Province of British Columbia

Ministry of Forests



Biogeoclimatic Zones and Subzones of the Cariboo Forest Region

ISBN 0-7719-8134-1



634.909
711
BCMF
RES
1979
MR5
C 1

106-06417/
(AMNC)
8473
mg 4430

BIOGEOCLIMATIC ZONES AND SUBZONES OF THE CARIBOO FOREST REGION

January 1979

Province of British Columbia
Ministry of Forests

Canadian Cataloguing in Publication Data
Main entry under title:
Biogeoclimatic zones and subzones of the Cariboo Forest Region.

Sponsored by Cariboo Region Research Advisory Committee.
Bibliography: p.
ISBN 0-7719-8134-1

1. Forest ecology - British Columbia - Cariboo Forest Region. 2. Cariboo Forest Region, B.C. 3. Forest ecology - Classification. I. Annas, R.M., 1941- . II. Coupe, R., 1952- . III. British Columbia. Ministry of Forests. Information Services Branch. IV. British Columbia. Ministry of Forests. Cariboo Region Research Advisory Committee.

QH541.5F6B56 574.5'264 C79-092046-8

PREFACE

This report is the result of a specific request by the Cariboo Forest Region for a broad scale reconnaissance stratification of ecological zones for resource management in the Cariboo region. The results of this work indicate that it is possible for resource managers from various disciplines to work together using a common base stratification of the environment. Hopefully, the end result will be better understanding and management of all resources.

It is stressed here, that biogeoclimatic zones and subzones are only one aspect of the ecosystem classification system being developed by the Ministry of Forests and that for site specific management, individual ecosystems must be recognized as belonging to a specific ecosystem or biogeocoenotic type. Although work is progressing in the Cariboo as well as in the other forest regions, much remains to be done in the classficiation of ecosystems at these lower (type) levels. This report presents in a general way the basic ideas behind the Ministry of Forests ecosystem classification and a brief current summary of the characteristics of zones and subzones in the Cariboo Forest Region.

R.L. Schmidt,
Acting Director.
Research Branch

January 1979

BIOGEOCLIMATIC ZONES AND SUBZONES OF THE CARIBOO FOREST REGION

R.M. ANNAS AND R. COUPÉ, EDITORS

CONTRIBUTING AUTHORS

R.M. ANNAS, MINISTRY OF FORESTS, VICTORIA, B.C. *Ecosystem classification, biogeoclimatic zones, subzones and vegetation.*

R. COUPÉ, MINISTRY OF FORESTS, WILLIAMS LAKE, B.C. *Biogeoclimatic zones, subzones and vegetation.*

W. WATT, MINISTRY OF FORESTS, WILLIAMS LAKE, B.C. *Soil, geology and physiography.*

J. PINKERTON, MINISTRY OF FORESTS, WILLIAMS LAKE, B.C. *Silviculture.*

A. VYSE, MINISTRY OF FORESTS, WILLIAMS LAKE, B.C. *Silviculture.*

J. HILTON, MINISTRY OF FORESTS, WILLIAMS LAKE, B.C. *Range management.*

M. BEETS, MINISTRY OF ENVIRONMENT, WILLIAMS LAKE, B.C. *Wildlife management.*

R. CHILTON, MINISTRY OF ENVIRONMENT, VICTORIA, B.C. *Climate.*

ACKNOWLEDGEMENTS

The foresters of the Cariboo Forest Region Research Advisory Committee must be thanked for requesting this study and for their continued support for this work. As regards to the system of ecosystem classification presented here, it must be stated that this classification is the result of a great deal of combined effort over the past several years by Research Branch pedologists and ecologists. L.M. Lavkulich must be thanked for critically reviewing our concepts of classification.

Many people have contributed directly to this report, with thanks going to Dan Blower for reviewing the wildlife section; to Ted Baker and Richard Smith for editing the report and to Jayne Lacroix for typing. Dan Blower, Marty Beets, Jim Hilton and Bill Watt contributed many of the photographs.

Additional inputs were received by the editors from M.A.M. Bell, V.C. Brink, A. McLean, T. Lord and J. van Barneveld who reviewed our zonal concepts in the field. All errors and shortcomings of this report are, however, the direct responsibility of the editors.

LIBRARY
MINISTRY OF FORESTS
PARLIAMENT BUILDINGS
VICTORIA, B.C.
V8W 3E7

TABLE OF CONTENTS

	PAGE
PREFACE	iii
LIST OF AUTHORS	iv
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS	vi
INTRODUCTION	xi
PART I	
ECOSYSTEM CLASSIFICATION AND RESOURCE MANAGEMENT	1
ECOSYSTEM CLASSIFICATION	
ECOSYSTEMS	2
ECOSYSTEM PROCESSES	2
ECOSYSTEMS AND CLASSIFICATION	3
THE MINISTRY OF FORESTS APPROACH TO ECOSYSTEM CLASSIFICATION	6
THE ECOSYSTEM LEVEL	7
ENVIRONMENT AND BIOTIC TERMS	7
ECOSYSTEM TERMS	7
THE ZONAL LEVEL	9
ZONATION AND NATURAL RESOURCE MANAGEMENT	12
PART II	
THE CARIBOO FOREST REGION	17
PHYSIOGRAPHY AND BEDROCK	18
CLIMATE	23
SOIL	29
MAPPING PROCEDURES	33
CHANGES IN ZONATION FROM KRAJINA'S ORIGINAL MAP	37

PAGE

PART III

ZONES AND SUBZONES 45

ALPINE TUNDRA - AT 46

ENGELMANN SPRUCE - SUBALPINE FIR - ESSF

ESSF (a) SUBZONE 50

ESSF (b) SUBZONE 53

MOUNTAIN HEMLOCK - MH 58

COASTAL WESTERN HEMLOCK - CWH 58

INTERIOR WESTERN HEMLOCK - IWH 58

IWH (CEDAR) SUBZONE 59

IWH (b) SUBZONE 63

SUB-BOREAL SPRUCE - SBS

SBS (a) SUBZONE 67

SBS (b) SUBZONE 72

SBS (c) SUBZONE 76

INTERIOR DOUGLAS FIR - IDF

IDF (a) SUBZONE 81

IDF (b) SUBZONE 88

IDF (c) SUBZONE 92

PONDEROSA PINE - BUNCHGRASS - PPBG 94

PART IV

BIBLIOGRAPHY 96

APPENDICES 100

TABLES

Table 1	Climatic Statistics	25
2	Snowdepth	28
3	Timber productivity	43
4	Temperatures - Junction Range	83

FIGURES

			PAGE
Figure	1.	Viewpoints towards an ecosystem	5
	2.	Classification and descriptive units	6
	3.	Successional development	9
	4.	Zonal ecosystem	10
	5.	Generalized geology	19
	6.	Physiographic subdivisions	19
	7.	Climate and landforms	24
	8.	Columnar basalt	31
	9.	Orthic Humo Ferric Podzol	31
	10.	Gleysol	32
	11.	Chernozem	32
	12.	Luvisol	32
	13.	Biogeoclimatic Zone Map	35
	14.	Cross section of zones	36
	15.	Grassland subzone	39
	16.	Chilcotin pine subzone	39
	17.	Chilcotin pine subzone	40
	18.	Douglas fir - pinegrass subzone	40
	19.	AT, Ilgachuz Mountains	47
	20.	AT - ESSF boundary	47
	21.	Nadila Creek	47
	22.	Pygmy forest, Perkins Peak	48
	23.	ESSF	48
	24.	ESSF(b)	55
	25.	ESSF(b)	57
	26.	ESSF, Mackay River	57
	27.	IWH(cedar subzone)	60
	28.	IWH	61
	29.	IWH(b)	61
	30.	IWH(b)	62

FIGURES (cont'd)

		PAGE
Figure 31.	IWH(b)	62
32.	IWH(b)	62
33.	IWH(b)	64
34.	SBS(a)	69
35.	SBS(a)	69
36.	SBS(a)	70
37.	SBS(a)	70
38.	SBS(b)	73
39.	SBS(c)	73
40.	SBS(b)	75
41.	SBS(b)	75
42.	SBS(c)	77
43.	IDF(a)	80
44.	IDF(a)	80
45.	IDF	84
46.	IDF(b)	86
47.	IDF(b)	86
48.	IDF(b)	87
49.	IDF(b)	87
50.	IDF(b)	89

INTRODUCTION

The purpose of this publication is twofold. Firstly an introductory discussion of the Ministry of Forests approach to ecosystem classification is presented. Secondly, this publication reports on the results of a reconnaissance study carried out on the zones and subzones of the Cariboo Forest Region and briefly outlines the more important physical, biological and resource characteristics of these zones. This represents the first phase of a systematic study to describe the various forest ecosystems of the Cariboo Forest Region for resource managers. It is to be expected that our concepts of zones and subzones will change as the classification of the province becomes more complete.

Addendum

Since this publication originally went to press, a new set of symbols have been proposed for the subzones on a provincial basis. Changes are as follows:

Present Symbols	New Symbols
ESSFa	ESSFg
ESSFb	ESSFh
IWH (cedar)	ICHe
IWHb	ICHa
IDFa	PPBGc (Big sage-bunchgrass, Fraser River)
"	PPBGe (Savannah, Beacher's Prairie)
PPBG	PPBGd

PART I

ECOSYSTEM CLASSIFICATION AND RESOURCE MANAGEMENT

R.M. ANNAS, R. COUPE, J. PINKERTON, A. VYSE, J. HILTON, M. BEETS

ECOSYSTEM CLASSIFICATION

ECOSYSTEMS - the objects being classified.

Ecosystems, the naturally functioning bodies in the landscape, are composed of organisms and their environment. Each ecosystem can be considered to be a result of the integration of five basic ecological factors: climate (c), organisms (o), relief (r), parent material (pm) and time (t). For resource managers and ecologists, a useful model of ecosystems is the following viewpoint or formula (Dokuchaev, 1898; Jenny, 1941; and Major, 1951):

$$V/S = f(c, o, r, pm, t)$$

Here V and S are vegetation and soil respectively. It is the vegetation and soil components of ecosystems that show the most conspicuous changes as a result of manipulation by resource managers and are of our most immediate concern.

Although the factors in the above equation interact with one another in countless chemical and physical processes, these processes can be grouped into one or more of four basic types: additions, removals, translocations and transformations. These categories were proposed for pedogenic processes by Simonson (1959). However, they are equally applicable to ecosystem (or biogeocoenotic) processes.

ECOSYSTEM PROCESSES

Additions: Additions include solar energy from the climatic component of the previous equation. This energy is in either the form of heat or light, both of which determine the development of organisms. The rate of reactions which govern ecosystem functioning is often controlled by heat. Precipitation, either as rain or snow, is another important addition from climate. Other additions include: seepage waters which contain dissolved nutrients; organic matter products from photsynthesis; elements from the weathering of soil parent materials; airborne particles (bulk precipitation) and gaseous elements.

Removals: Included in removals are such factors as the oxidation of organic matter by decomposers to H_2O and CO_2. These compounds are generally lost from the system through either the atmosphere or the soil. Losses of nutrients can take place by surface runoff of precipitation or by the leaching of soluble salts by water percolating through the soil. Fire results in losses of organic matter, nitrogen and energy to the atmosphere and can increase the susceptability of other nutrients to removal by leaching. Additionally, organic compounds are removed and lost from the system through harvesting by animals (including man).

Translocations: Translocations refer to the movement of matter or energy from one part of the system to another. Nutrient cycling in which nutrients are taken in by the roots and eventually assimilated into organic compounds in leaves, stems and roots is included in this category. In the soil, zones of removal and zones of accumulation are associated with translocations. The movement of clay from the surface mineral soil (A horizon) to the B horizon is an example of such a translocation in Luvisols. In Podzols, iron and aluminum sesquioxides accumulate in the B horizon.

Transformations: Transformations are changes in constituent parts of ecosystems from one form to another. In the soil transformations can be the processes of weathering of primary minerals to clay minerals and the releasing of cations or the changes of iron ions between the oxidized and reduced state. The process of photosynthesis transforms solar energy, CO_2 and H_2O into organic compounds with high energy content. Other processes, including those of decomposers, transform these compounds by oxidation to release energy and nutrients.

ECOSYSTEMS AND CLASSIFICATION

Examining ecosystems and their processes indicates that they are tremendously complex and to fully understand all the intricacies of even one ecosystem is beyond the capabilities of the human mind. It is however, an inescapable fact that resource users have no choice but to be ecosystem managers and to effect change in essentially all the previously mentioned ecosystem processes and characteristics. This happens regardless of how much is known about the particular ecosystem being managed.

In order for us to effectively cope with numerous complex unique

systems with any degree of sanity, we must first classify them into a realistic number of units. The members of these units must have as many similar characteristics and properties as possible for the units to be truly meaningful. To classify, one needs readily identifiable characters which best reflect the inherent properties of the objects being classified. The obvious results of such classifications are that our powers of prediction are increased. Since we are dealing with ecosystems we require an ecosystem classification - not a soil classification or a vegetation classification but an ecosystem classification.

Soil information by itself provides us with knowledge about part of the properties of the site, however, information concerning the physiological characteristics required to predict plant growth is often lacking. The biotic component of ecosystems can be used to produce a classification which is both meaningful and easy to use but it has significant limitations concerning physical characteristics of the site. Contained in each organism is the information required for its existence. This includes the information utilized by organisms to extract life from a world of energy and nutrients and a world strongly modified through competition with other organisms. It can be assumed that many of the physical and chemical processes operating in the real world, but as of yet not understood or known to man, may be grouped together simply by grouping the end results of these processes, namely the organisms (in our case limited to vegetation) and soils, the two factors on the left of the previous equation.

Vegetation and soils, when considered simultaneously, are generally considered to contain the most suitable attributes of ecosystems upon which to base an ecosystem classification for most uses. However, the more factors utilized in constructing the classification, the better will be its predictive powers, and the wider will be its use.

Figure 1 illustrates the important point that ecosystems can be examined, studied or treated from an almost unlimited number of perfectly valid viewpoints. All viewpoints are ultimately interrelated since in reality, no one thing or part of an ecosystem can be considered in isolation. The part or parts of the ecosystem which are emphasized or brought into central view will depend on the interests of the scientist or resource manager. However, the other viewpoints should not be forgotten. The figure also indicates that an almost unlimited amount of information must

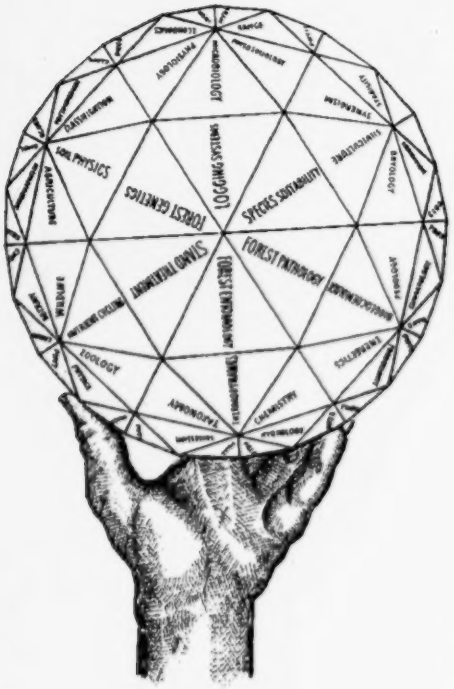


Figure 1.

be contained in the ecosystem description to satisfy the needs of all the viewers. Although satisfying all needs is ideal, it is impossible and all that can be hoped for is improved approximations towards this ideal.

An additional consideration in characterizing and classifying ecosystems is that the size or scope of the individual ecosystem will vary according to the viewer. For example, a hydrologist may want to investigate ecosystems at the watershed level while a bryologist may want to study them at the level of a rotting log. The level at which ecosystems are considered for characterization and classification must, therefore, arbitrarily be selected with the interests of the viewer in mind.

In summary, there can be no ideal classification but only "good" classifications from particular viewpoints. The classification system being developed by the Ministry of Forests is a tool for forest (including range and wildlife) managers and scientists and is aimed to serve as many facets or viewpoints of forest and forest land management as possible.

THE MINISTRY OF FORESTS APPROACH TO ECOSYSTEM CLASSIFICATION

The ecosystem classification systems utilized in this study by the Ministry of Forests was originally developed by V.J. Krajina and his students at the University of British Columbia (Krajina, 1959, 1960, 1965, 1969, 1971, 1972, 1973; Mueller-Dombois and Ellenberg, 1974). Our basic philosophy is to follow Krajina's classification as closely as possible. However, where we felt our findings require modifications to Krajina's system, we have made the necessary changes.

The biogeoclimatic system of ecosystem classification as utilized here is divided into the primary levels: the zonal (biogeoclimatic) level and the ecosystem (biogeocoenotic) level. The ecosystem level is concerned with classification of individual ecosystems occurring on the landscape. The zonal level deals with the distribution of ecosystems on the landscape in relation to the macroclimate.

RELATIONSHIP BETWEEN CLASSIFICATION UNITS
AND DESCRIPTIVE OR MAPPING UNITS
(definitions of units follow)

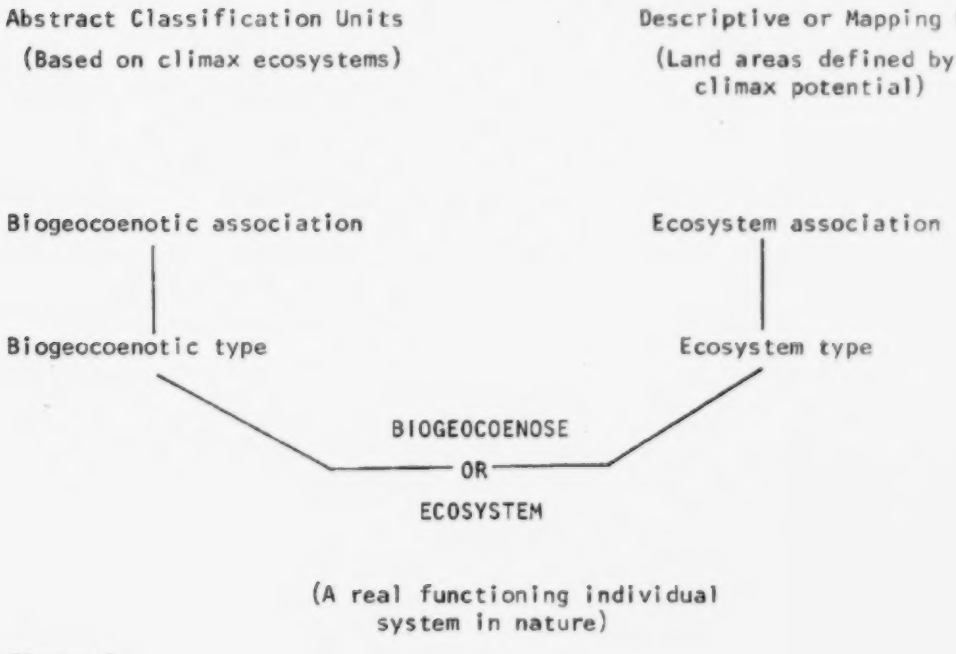


Figure 2.

THE ECOSYSTEM LEVEL

The following is a brief definition of the more important terms used in ecosystem classification.

ENVIRONMENT AND BIOTIC TERMS

POLYPEDON: A polypedon is a soil individual found in nature (has geographical bounds) whose properties vary within a narrowly defined range.

SOIL FAMILY: A soil family is a group of soils having a limited range of variability in the following properties; particle size, mineralogy, reaction (pH), depth, and soil climate (including temperature and moisture). A soil family is an abstract class in soil classification.

PLANT COMMUNITY: A plant community is the vegetation subsystem of a biotic community. According to Whittaker (1970), a community is an open energy system; climax communities are characterized by steady states of populations, energy flow, and matter. For our purpose, a plant community is defined as an area (has geographical bounds) which is relatively uniform in terms of plant species composition and vegetation structure.

PLANT ASSOCIATION: A plant association is a group of similar plant communities which is described mainly in terms of a characteristic combination of species. A plant association is an abstract class in vegetation classification. It is conceived (derived) from examination of a number of communities found in the field, each of which should have the minimum of characteristics which personify the association under all circumstances (Poore 1955). The level at which the plant association is considered (in terms of vegetation only) is essentially identical to what has been used by Krajina and his students (as for example in Beil (1974), Brayshaw (1970), Wali and Krajina (1973) and Kojima and Krajina (1975).

ECOSYSTEM TERMS

BIOGEOCOENOSE OR ECOSYSTEM: A biogeocoenose or ecosystem is a naturally functioning system in the landscape and is composed of organisms (the biotic subsystem) and their environment (the abiotic subsystem). It is a real body occurring in nature (has geographical bounds) and its size is limited by the size of the plant community and the size of the

soil polypedon upon which the plant community occurs. A biogeocoenose is a special case of the ecosystem defined by Tansley (1935), however, for simplicity we are using the two terms interchangeably. It is in the sense of Sukachev and Dylis' (1964) description of a biogeocoenose that we are using the term or as used by Klinka (1976).

BIOGEOCOENOTIC TYPE: A biogeocoenotic type is an abstract unit which is defined on the basis of similarities in both vegetation and soils. The biogeocoenotic type must contain members with vegetation which belongs to the same plant association and soils that belong to the same soil family.

It should be stressed that for ecosystem classification, only climax plant communities, or where necessary advanced seral communities are used for defining the conceptual abstract classes such as biogeocoenotic type and biogeocoenotic associations.

ECOSYSTEM TYPE: An ecosystem type is defined as all land areas capable of producing plant communities belonging to the same plant association at climax on polypedons of a single soil family, or all land areas potentially belonging to the same biogeocoenotic type.

BIOGEOCOENOTIC ASSOCIATION: A biogeocoenotic association is an abstract unit above the biogeocoenotic type that theoretically is characterized by moisture regime, nutrient regime, vegetation, and patterns of energy flux. At the present time, primarily vegetation is used to approximate a characterization. The biogeocoenotic association therefore represents a grouping of biogeocoenotic types which have similar plant communities. The level at which the biogeocoenotic type is used is similar to that of Krajina's 1960 modification of Braun-Blanquet's plant association.

ECOSYSTEM ASSOCIATION: The ecosystem association is defined as all land areas capable of producing plant communities belonging to the same plant association at climax or all land areas potentially belonging to the same biogeocoenotic association. Our use of the term ecosystem association is similar to the term habitat type used by Daubenmire (1968), Franklin and Dyrness (1973) and Pfister et. al., (1977). However, the ecosystem association in our approach, like the ecosystem type represents a group of ecosystems of similar potential and therefore is used only as a mapping or descriptive unit.

THE ZONAL LEVEL

BIOGEOCLIMATIC ZONE

A biogeoclimatic zone is defined here as a definite geographical area having basically similar patterns of energy flow, biogeochemical cycling, vegetation and soils as a result of a broadly homogeneous macroclimate. A biogeoclimatic zone is usually named after one or more of the dominant shade-tolerant trees which are capable of self regeneration on most of the habitats.

As a rule each biogeoclimatic zone can be broken down into several subzones on the basis of biogeocoenotic associations on mesic sites. The following is a brief description of concepts regarding topoedaphic and climatic climaxes and their succession which are discussed here to aid understanding the definition of subzones.

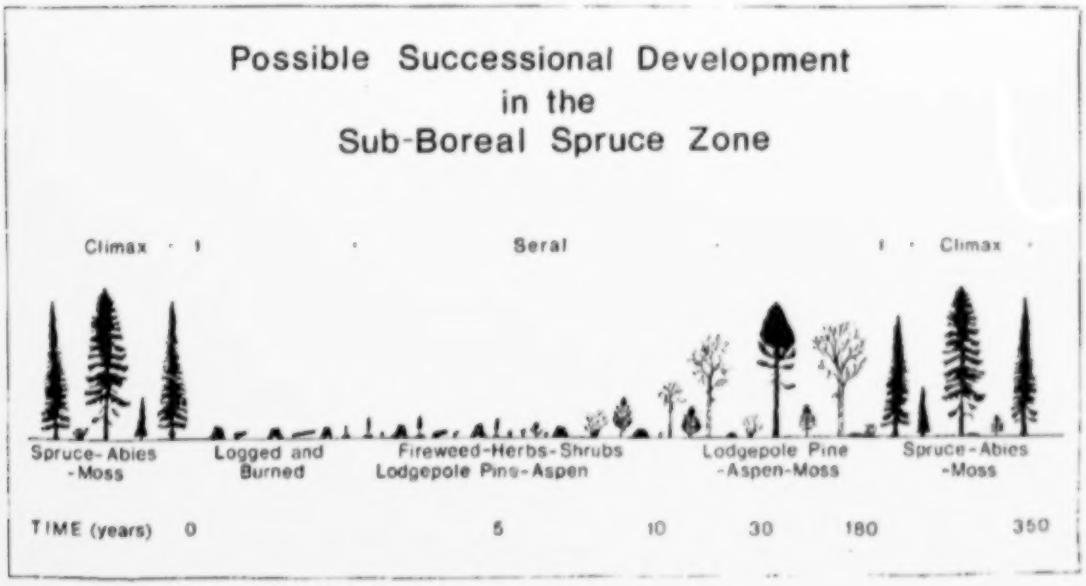


Figure 3.
Succession and the Climax Community

The above diagram indicates the various types of plant communities which can occupy a given site. After logging and burning, the ground is relatively bare with many unoccupied niches. Opportunist species, such as fireweed and grass species, will initially colonize the site. These species thrive well until crowding initiates competition. The plants best adapted

to the site will eliminate species not well suited for that particular environment thereby causing changes in composition with time. In the above case, shade intolerant species on the forest floor will be eliminated as seedlings of aspen and lodgepole grow and increase shading. As time progresses these shade intolerant trees are replaced by the more shade tolerant white spruce and subalpine fir. Eventually further changes in the vegetational composition of the communities becomes negligible and the community is then considered to be a climax.

It is this climax community which is used in most ecological classifications to characterize a site. Climax species are considered to be the best indicators of the environmental conditions of that site. Seral plant communities change or may be maintained artificially through plantations or through frequent cuttings. The important point is that even though various or changing plant communities can occupy the site, the potential climax community is constant and will not change unless the environment is radically altered.

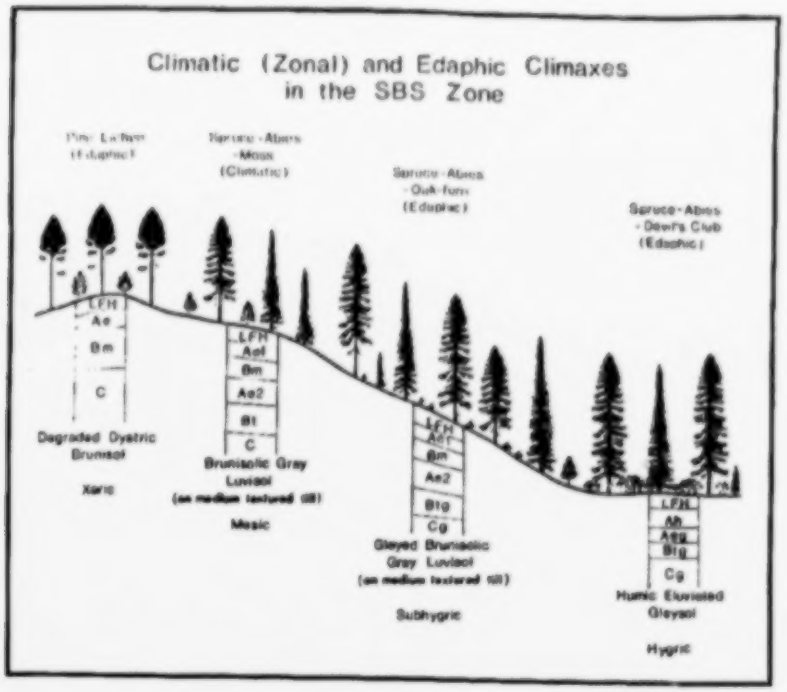


Figure 4.

Climatic and edaphic climaxes

The preceding simplified diagram illustrates the relative position of a mesic ecosystem or biogeocoenose (mesic soil and zonal plant association) in the "C" subzone of the sub-boreal spruce zone in the Cariboo Forest District. In any given region there are a wide variety of climax biogeocoenosis (ecosystems) depending upon topographic position and parent material. In the above case the Pine - Lichen association develops on sandy soils where drainage is extremely rapid. This vegetation is thus more of a reflection of rapid drainage than macroclimate and the vegetation on such sites will develop into a topoedaphic climax. The Spruce - Abies - Moss association develops on medium textured soils and therefore is moderately to well drained. No seepage water is present here, and the soil and vegetation best reflect the macroclimate. The Spruce - Abies - Moss association is therefore referred to as the climatic or zonal association and represents a climatic climax. The two other biogeoclimatic associations (the Spruce - Abies - Oak-fern and the Spruce - Abies - Devil's club) develop on soils which are influenced by seepage from the higher elevations. Again the vegetation and soils are highly influenced by factors other than the macroclimate - basically the nutrient laden seepage water and represent topoedaphic climaxes.

BIOGEOCLIMATIC SUBZONE

A biogeoclimatic subzone is a geographical area having a distinct biogeocoenotic association on zonal sites. When soils are of intermediate texture, are not excessively drained or subject to seepage waters, and are in a normal or average topographic position, in gently undulating terrain, they are considered mesic as to moisture regime. It is this site which best reflects the macroclimate of an area provided that these sites have average nutrient regimes for the subzone. Therefore, a subzone is relatively homogeneous as to patterns of soil and vegetation distribution as well as to macroclimate. Each subzone has its own moisture and nutrient regimes which can be projected onto an edatopic grid.

ZONATION AND NATURAL RESOURCE MANAGEMENT

The most important function of ecological zonation to natural resource managers is that it provides a framework allowing knowledge about various resources to be organized within a system which has a common denominator. It also provides a basis for developing and comparing present and future management procedures. In organizing knowledge in this type of framework a better understanding of the causes of successes and failures of management activities can be gained and the amount of speculation as to the outcome of these activities can be reduced.

In the Cariboo Forest Region three of the most important renewable natural resources are timber (inclusive of wood fibre), range and wildlife.

SILVICULTURE

In the management of timber resources, silviculture, deals with the technical details of forest crop production. In the district, as is the case for much of the province, silviculture is still much an intuitive art, but new knowledge and improved techniques are steadily improving silviculture as a science. Although timber harvesting is the principle forest activity in the region more time and energy are now being applied to silvicultural activities such as reforestation and stand management. Examples of how ecological zonation can be applied in silviculture are: establishing seed zones and provenance areas; delineating broad areas where such problems as pathological infestations occur or where certain silvicultural systems can be applied; delineating priorities on the basis of productivity and in general forestry planning. With the information derived from an ecological classification, general guidelines, recommendations and policies can be drawn up which will maximize timber production while minimizing the negative effects of forestry activities on the other components of ecosystems.

RANGE MANAGEMENT

Range management, attempts to maximize the production of domestic livestock (mostly cattle in the region) without degrading the condition of the range. The region's range resources are comprised of basically two types of range: open grassland steppe and forested range with the latter being the most extensive of the two. Two other types of range which occur in the region , but on a more limited basis, are the wetland sedge meadows and the subalpine - alpine forb meadows.

The advantages of using biogeoclimatic zonation as a tool in range management are similar to those mentioned for timber management in that it provides a framework to organize range knowledge (grazing history, forage species distribution, and potential stocking rates) and to base broad planning of the range resource. Even though biogeoclimatic zones and subzones are broad, their usefulness in formulating management plans become apparent when range knowledge is correlated with ecological zonation of the region. For example, grazing history and forage species distribution indicates that some of the largest and most productive ranches of the region were first established along the Fraser River and its major tributaries (the grassland subzone of the IDF). The climate of this area favours the establishment of grassland communities due to its long warm and dry growing season. Because of poor management practices in the past the overall condition of this subzone is much lower than its potential. Since it has the highest potential for livestock production over any other area in the region it should be managed most intensely for this purpose.

WILDLIFE

Food, water and shelter are the three basic requirements necessary to the survival of all wildlife species. Because each species of wildlife is unique in its physical makeup, it is also unique in the type of habitat in which it can survive and maintain itself. For example, sharptail grouse are a grassland bird while ptarmigan have adapted to the higher elevation semi-alpine habitat. Mountain caribou have very large feet which enable them to walk on deep snow where a mule deer could not manage.

When considering the distribution of wildlife species within our region, some species occur in very discrete locations while others are spread throughout the region. When we compare biogeoclimatic zones with the known distribution of various wildlife species, a pattern begins to emerge. Wildlife species that prefer certain habitats are confined to the zones that supply those needs.

Although year round habitat is essential, winter is often the critical time for many big game species in the Cariboo region. An adequate food supply is essential, however, unavailability of the food supply because of deep snow or lack of cover can be a major limiting

factor for survival.

Natural habitat requirements of a wildlife species may not be compatible with land use practices of man. For example, converting a willow swamp to hay production would destroy a moose winter range.

The management of each species as a separate entity is not possible at the present time and probably never will be practical. Since it is obvious that we cannot manage or protect the habitat of each wildlife species in isolation, "ecosystem management" for wildlife species is therefore necessary. For most wildlife species, the key to ecosystem management is habitat diversity. Habitat diversity means simply maintaining a variety of habitats in a particular area. When logging applications are reviewed, recommendations might be made that the area be logged in such a way that reserve strips are left between cut blocks to provide cover and that logging occur with small cut blocks over an extended period of time rather than creating large cut blocks all at once. These diverse habitats will then be available for the particular wildlife species needing them.

If it weren't for human activity, we would have little need to alter the natural phenomenon affecting wildlife habitat. It is obvious that logging on a dry south slope where annual precipitation is 25 cm per year is going to have a much different affect than on a coastal forest with 375 cm of precipitation per year. The understanding and defining of biogeoclimatic zones is an aid in the management and protection of wildlife habitat. The division of zones into subzones further defines specific areas with similar climate and vegetation. Being able to predict vegetation response to human activity in a well defined area such as a subzone should help us maintain habitat diversity even though activities such as logging and grazing are occurring.

The first step in understanding the relationship between wildlife and a biogeoclimatic zone is to know what species or groups of wildlife use a particular zone or subzone. Wildlife activity related to each zone or subzone will be covered during the following discussions.

It should be emphasized that the use of biogeoclimatic subzones as a tool for managing renewable natural resources is for the most part limited to fairly broad levels of management. At more refined levels of management, for example at operational levels, a more detailed level of ecological classification (at the biogeocoenosis or ecosystem type

level) is required. At present, very little of this type of information has been derived for the Cariboo Forest Region, however, work is progressing at this detailed level. It remains for the future to do system analysis of these ecosystems to better understand biogeochemical cycling and ecosystem processes. This will help remove some of the present intuitive approaches, thereby making ecosystem management a more rigorously objective science.

PART II

THE CARIBOO FOREST REGION
MAPPING PROCEDURES AND THE BIOGEOCLIMATIC MAP

W. WATT, R. CHILTON, R. ANNAS, R. COUPÉ

PHYSIOGRAPHY AND BEDROCK

The major physiographic features of the Cariboo Forest Region which dominate the landscape have enormous effects on air flow patterns and climate. Additionally, physiography and bedrock play a dominant role in influencing soil properties. Hence, physiography and bedrock characteristics are two important geologic features which ultimately have large influences on ecosystems in the Cariboo.

The major physiographic features of the Cariboo Forest Region have resulted from geologic processes acting slowly over long periods of time. The bedrock itself has undergone modification through mountain building, glaciation, and erosional activities. Where the bedrock is massive and flat lying, the landscape is smooth and rolling. Tectonic activity (deformation of the earth's crust) has caused folding and faulting of the bedrock, creating upland areas which have subsequently been glaciated and eroded. Apart from tectonic activity volcanism, glaciation and stream erosion have dominated the shaping of the many landscapes.

The Cariboo Forest Region may be divided into two major physiographic regions - the Western and the Interior Systems (Holland, 1964). Within the district, the Western System consists solely of the Coast Mountains. The Interior System contains the Fraser Plateau, the Fraser Basin, the Nechako Plateau, Quesnel Highlands and the Cariboo Mountains. Most of the following discussion has been abstracted from Holland (1964).

THE COAST MOUNTAINS

The Coast Mountains occur along the western edge of the region and consist of two main ranges - the Pacific and Chilcotin Ranges.

The Pacific Ranges are formed primarily from intrusive igneous (granitic) rock. Drainage in this area is largely controlled by bedrock structure. This range contains the highest mountains in the district, with Mount Waddington (4000 m) being the highest. Areas of extensive icefields occur in this range and the higher peaks have been sculptured by cirque glaciers. High relief, shallow surficial deposits, commonly exposed bedrock and frequently occurring cirque glaciers characterize these high mountains.

The Chilcotin Ranges are largely composed of folded and faulted volcanic and sedimentary rocks. These mountains rise progressively from the Fraser Plateau in approaching the Pacific Ranges.

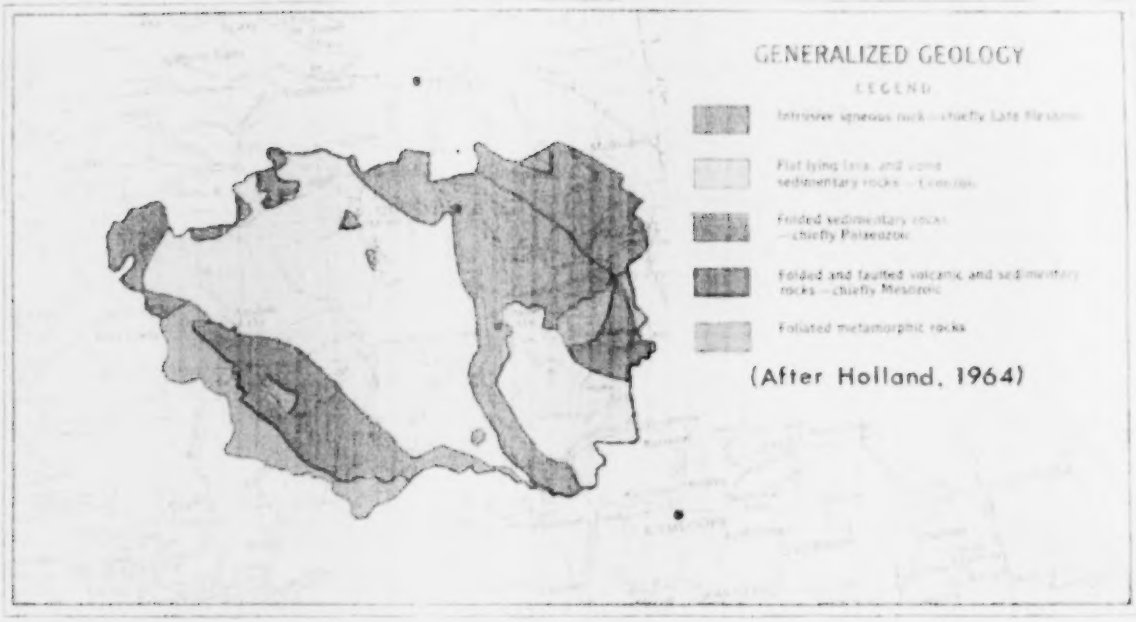
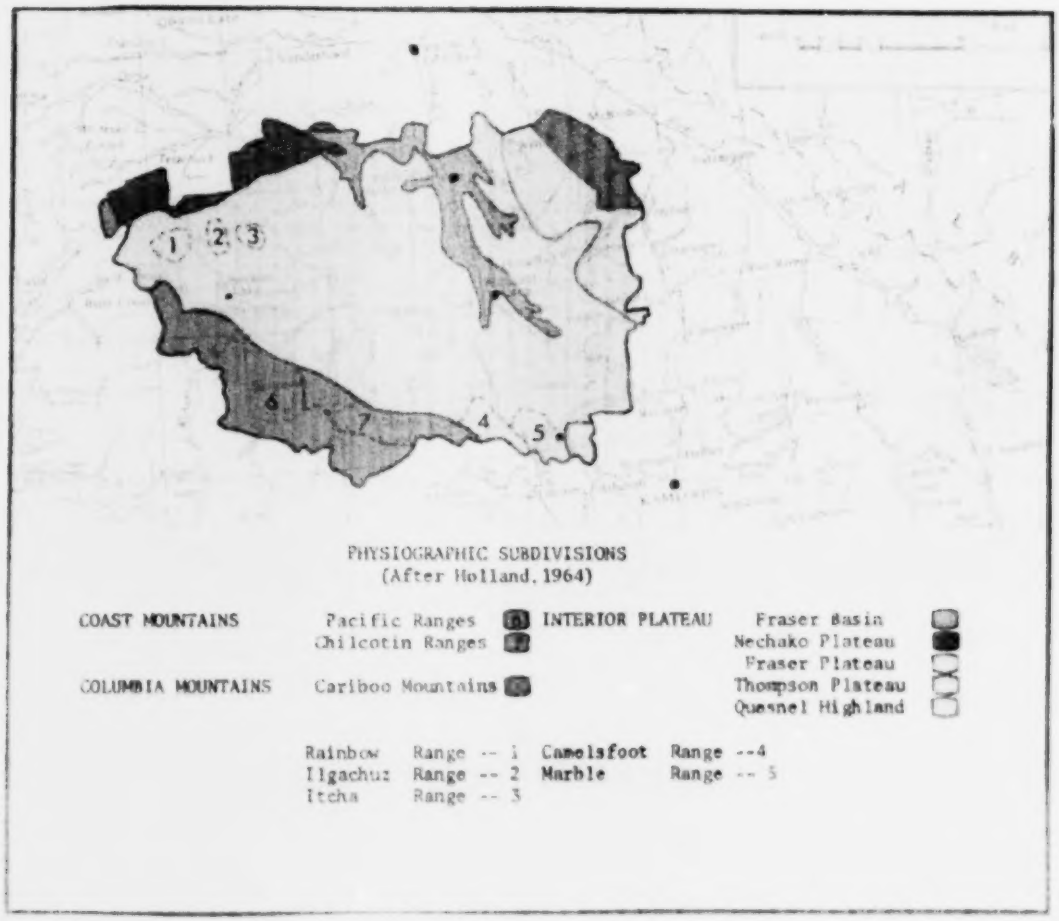

GENERALIZED GEOLOGY
LEGEND
Intrusive igneous rock -- chiefly Late Mesozoic
Flat lying lava and some sedimentary rocks -- Cenozoic
Folded sedimentary rocks -- chiefly Paleozoic
Folded and faulted volcanic and sedimentary rocks -- chiefly Mesozoic
Foliated metamorphic rocks
(After Holland, 1964)

Figure 5.


1
2
3
4
5
6
7
PHYSIOGRAPHIC SUBDIVISIONS
(After Holland, 1964)
COAST MOUNTAINS
Pacific Ranges
Chilcotin Ranges
COLUMBIA MOUNTAINS
Cariboo Mountains
INTERIOR PLATEAU
Fraser Basin
Nechako Plateau
Fraser Plateau
Thompson Plateau
Quesnel Highland
Rainbow Range -- 1
Ilgachuz Range -- 2
Itcha Range -- 3
Camelsfoot Range --4
Marble Range -- 5

For the most part, the Chilcotin Ranges are a combination of two types of summits as a result of glaciation. The high serrate peaks have been subjected only to alpine glaciation. The lower mountains, characterized by rounded summits and gently sloping undissected uplands were overridden by Pleistocene ice. Glaciation has generally modified valley profiles into the typical U shape throughout this area.

THE FRASER PLATEAU

The Fraser Plateau is singularly the most extensive physiographic feature of the region . Generally it is a gently rolling plateau formed primarily by flat or gently dipping basalt lava flows. These flows are most frequently noticed at steep escarpments along rives and creeks.

A blanket of glacial drift covers most of the plateau and is comprised of basal till, ablation till and glaciofluvial deposits. Generally the low hills of the plateau have shallow surficial deposits with deeper deposits in the depressions between the hills.

Several smaller divisions of the Fraser Plateau can be recognized in the district. In the northwest, the volcanic Rainbow, Ilgachuz and Itcha Ranges rise approximately 1250 metres above the general level of the plateau to heights of over 2100 metres. To the south lie the Marble and Camelsfoot Ranges. The Marble Range has rugged relief characterized by V-shaped valleys and sharp intervening ridges. This range is predominantly made up of limestone; the associated surficial materials are, therefore, highly calcareous. The Camelsfoot Range is comprised of flat lying lava and sedimentary rocks which have undergone some folding and faulting. In both ranges, volcanic ash appears in the surface mineral soils as a result of the Bridge River eruption.

THE FRASER BASIN

The Fraser Basin occurs as a subtle depression adjacent to the Fraser, Quesnel, West Road and San Jose Rivers which extends northward from Lac La Hache to McLeod Lake. Its elevation is generally below 1000 metres. The bedrock is predominantly folded and faulted volcanic and sedimentary rocks. Bedrock exposures are not extensive. Surficial deposits are variable and include glacial, fluvial, colluvial, and aeolian deposits. Topography varies from steep erosional scarps, to flat terraces along the rivers.

THE QUESNEL HIGHLAND

The Quesnel Highland is bound on the west by the Fraser Plateau and on the east by the Cariboo Mountains. They are formed partially from the remnants of a highly dissected plateau of moderate relief. Most of the highland consists of folded and faulted volcanic and sedimentary rocks. Limestone and quartzite form many of the high peaks.

All but the highest peaks were overridden by Pleistocene ice. The highlands bear a moderately continuous blanket of glacial deposits in an otherwise bedrock controlled topography.

THE CARIBOO MOUNTAINS

The Cariboo Mountains lie east of the Quesnel Highland. Their high relief, massiveness and accessibility provide high recreational values as in the Bowron Lakes area. These mountains are composed of sedimentary rock and metamorphosed sedimentary rock. Quartzite is the principal rock type although some limestone is also present.

Valleys in this region are steep sided and surficial deposits are shallow except locally in valley bottoms. Typical U-shaped valleys with hanging valleys entering into them are common in these mountains.

NECHAKO AND THOMPSON PLATEAUS

The Cariboo Forest Region also contains portions of the Nechako and Thompson Plateaus. The Nechako Plateau, which occurs in the extreme northwestern portion of the district, north of the West Road River, is an area of low relief, with great expanses of flat or gently rolling country. Within this area are also included two round-topped ranges: the Nechako and Fawnie Ranges. The Thompson Plateau in the district occurs only as a small area near Clinton and is of minor significance.

SURFICIAL LANDFORMS

Most of the Cariboo Forest Region was last glaciated during the Pleistocene Period. During this time, ice accumulated in the Cariboo and Coast Mountains and then flowed out across the plateau. Ice flow from the Cariboo Mountains was southwesterly while the flow from the Coast Mountains was easterly and northeasterly. Ice moving from the west carried

with it coarse grained igneous materials from the Coast Mountains; consequently, glacial tills close to this source in the mountains are coarser textured than those derived from the basaltic bedrock of the plateau. (As a general rule, coarse grained rocks weather more slowly than fine grained rocks and nutrients are liberated more slowly. Soils derived from coarse grained rocks thus have a generally poor nutrient status).

The dominant surficial material on the gentler topography of the district is of glacial origin. Higher elevations and steep slopes associated with the mountainous terrain have colluvial deposits (laid down under the influence of gravity). Fluvial deposits (laid down under the influence of running water) occur locally, adjacent to streams. Often areas have aeolian (wind blown) deposits overlying the tills. Surficial aeolian deposits are especially obvious in the Beacher's Prairie area west of Williams Lake. Other smaller areas have fine textured parent materials of lacustrine origin which were laid down in old lake beds.

CLIMATE

The general spatial trends of climate within the Cariboo Forest Region are governed largely by latitude, elevation and position in relation to the mountains of the region. (See Table 1 and Figure 7 for climatic trends).

The region is in the lee of the Coast Mountains, and consequently, the effects of moist Pacific air are not very appreciable. This is particularly true, in the area of the Fraser and Nechako Plateaus. Very light precipitation and a high frequency of clear skies produces a relatively dry climate regime. The high elevation of the plateau lands result in a short frost free period in addition to the dry climate.

East of the Fraser, as the higher lands of the Quesnel Highlands and the Cariboo Mountains are attained, uplift of the westerly air flow results in increased cloud cover and precipitation from areas to the west.

In progressing from the southern part of the region towards the north, a pattern of distinct cooling is noticeable as represented by the growing degree days, frost free period, and January mean temperatures (Ashcroft to Quesnel).

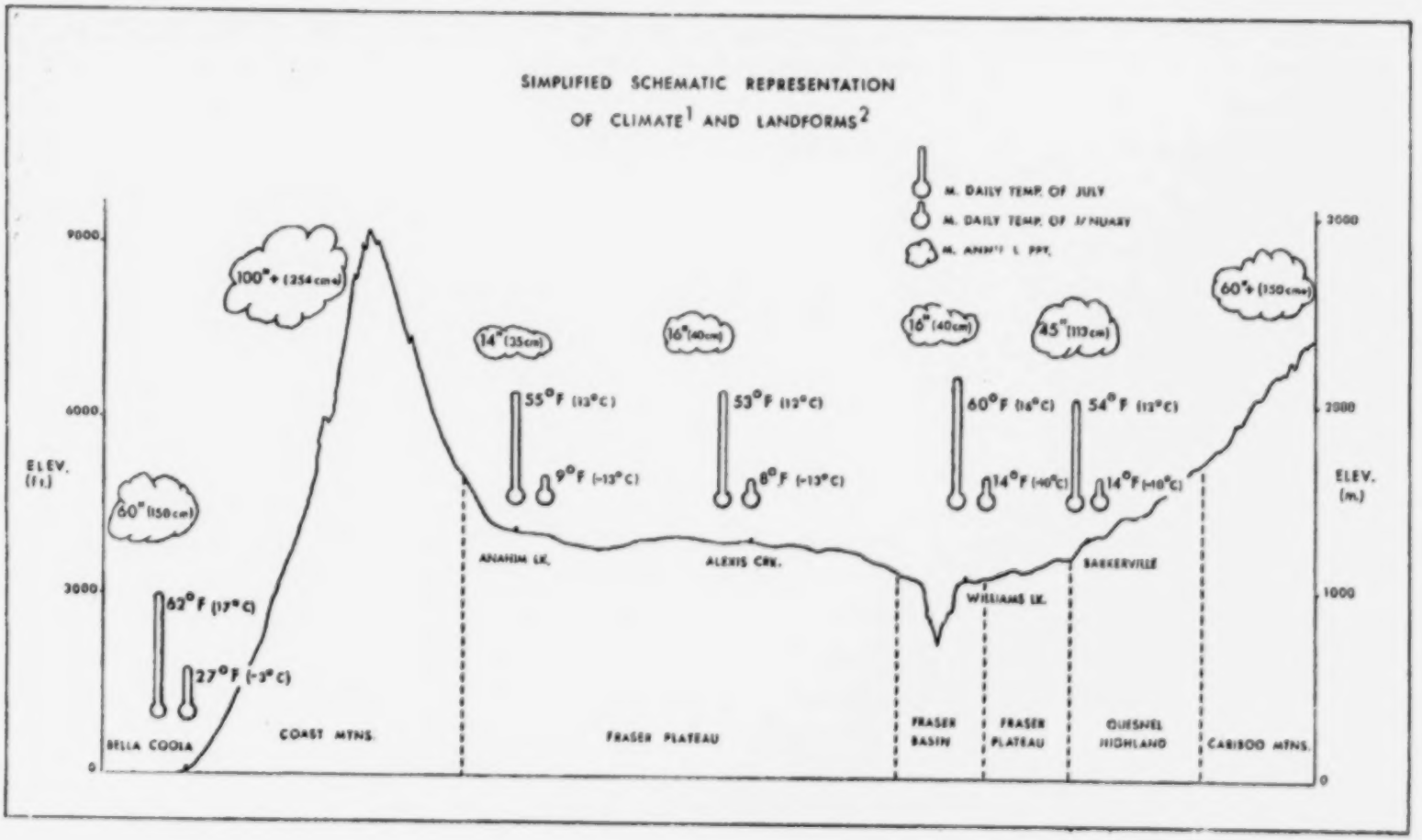
Also, a much wetter regime is apparent as one progresses north of the Ashcroft-Clinton area. This trend to wetter conditions can in part be attributed to the Coast Mountains being less prominent in height and extent north of about 52°N.

CLIMATIC CHARACTERISTICS OF THE CARIBOO FOREST REGION

Beginning in the south, the Ponderosa Pine - Bunchgrass zone and the Ponderosa pine - Douglas fir subzone of the IDF (Figure 7) are characterized by relatively long dry summers, moderately long frost free periods, and cool but dry winters. It is the nature of this area to have high rates of potential evapotranspiration. Consequently, the region may be considered quite arid overall. Ashcroft Manor data (Table 1), illustrates the area's predominantly rain shadow climate.

Precipitation is light in the Ponderosa Pine - Bunchgrass zone but increases significantly to the north of this zone (annually 235.0 mm in Ashcroft region to 393.4 mm in Dog Creek area to 541.3 mm at Quesnel).

Figure 7.



1. after Chapman (1952)

2. after Holland (1964)

TABLE 1. CLIMATIC STATISTICS FOR THE CARIBOO FOREST DISTRICT *

ZONE OR SUBZONE	STATION	ELEV. (ft.)	ELEV. (metres)	GDD based on 5.6°C	FFP 0°C	Ann. Ppt. (mm)	May-Sept. Ppt. (mm)	Percentage May - Sept. is of total	Mean Jan. Temp. 0°C	Average Annual Snowfall (cm)
PONDEROSA PINE-BUNCHGRASS PPBG	Ashcroft Manor	1600	488	1952	143	235.0	108.2	46.0	-7.6	79.8
GRASSLAND SUBZONE IDF (a)	Dog Creek AP	3370	1027	1216	105	393.4	199.6	50.7	-10.3	167.1
DOUGLAS FIR-PINEGRASS IDF (b)	Big Creek	3720	1134	916	44	340.6	187.5	55.0	-11.6	137.2
	Tatlayoko Lake	2780	829	1047	57	426.0	146.3	34.3	-8.1	144.0
	150 Mile House	2900	884	1258	76	425.5	222.0	52.2	-11.2	142.5
IDF-SBS Transition	Puntzi Mountain	2990	912	937	22	290.3 Based on Big Cr. (est.)	167.9 Based on Big Cr. (est.)	57.8 (est.)	-13.9 (est.)	127.8 (est.)
DOUGLAS FIR-WHITE SPRUCE SUBZONE SBS (b)	Williams Lake	3088	941	1322	92	401.6	206.8	51.5	-10.2	152.7
	Horsefly Lake	2585	788	-	-	703.1	377.7	53.7	-8.7	192.8
	Quesnel A.	1787	545	1341	99	541.3	259.3	47.9	-11.3	192.8
CHILCOTIN PINE SUBZONE SBS (a)	Kleena Kleene	2950	899	863	26	356.6	147.6	41.4	-12.5	166.9
	Alexis Creek/ Tautri Creek	4000	1220	-	12	418.8	213.6	51.0	-13.6	166.6
ENGELMANN SPRUCE-SUBALPINE FIR ESSF	Boss Mountain	5009	1527	-	-	1263.7	398.0	31.5	-8.9	899.5
	Barkerville	4179	1274	669	49	1148.8	473.7	41.2	-9.8	581.4

GDD - Growing Degree Days - Degree Days accumulated above 5.6°C base
FFP - Frost Free Period
Ann. Ppt. - Annual Precipitation

Reference: Atmospheric Environment Service
Climate Information

*District = Region

LIBRARY
MINISTRY OF FORESTS
PARLIAMENT BUILDINGS
VICTORIA, B.C.
V8W 3E7

Westwards, on the plateau, only slightly different precipitation amounts are observed from those at the rim of the Fraser Canyon. The Dog Creek Airport at the edge of the Fraser Canyon (elev. 1027 m) has a precipitation of 393.4 mm as compared to 340.6 mm at Big Creek on the plateau and 401.6 mm at Williams Lake. As precipitation and cloud cover increase the climate becomes cooler and the climatic moisture deficit (potential evapotranspiration minus precipitation) is less pronounced. The result, at least in part, is responsible for the various subzones of the Interior Douglas fir and Sub-boreal spruce biogeoclimatic zones.

West from the Fraser River, on the Fraser Plateau, frost free periods shorten and growing degree days lessen (indicated by a comparison of Dog Creek Airport and Big Creek). The higher elevation flat lands encourage the formation and retention of cooler air compared to Fraser Canyon lands. It is not until nearer the Coast Range that the wetter, snowier regime results, at least in part, in the Engelmann Spruce zone (ESSF (a)).

The initial part of this trend can be seen in the information presented for the Atmospheric Environment Service stations at Tatlayoko Lake and Big Creek (Table 1). At higher elevations (as represented by Tatlayoko Lake snow course) snowpacks become deeper and more prolonged. The more substantial snowpacks and the cooler shorter growing season appear to be major contributing factors in the occurrence of the Engelmann Spruce zone. The start of the Coastal Western Hemlock zone corresponds with a significant increase in precipitation, and an area much more coastal in nature. This Coastal Western Hemlock zone is subjected to milder and very much wetter conditions than in those zones in the lee of the Coast Range. Higher up, on both sides of the Coast Mountains, heavy snows and very short growing seasons lead to Subalpine Mountain Hemlock and then Alpine Tundra zones.

A very interesting feature of the precipitation regime is the seasonal pattern of precipitation. Within the Fraser Canyon, approximately 50% of the precipitation falls in the months May to September. Immediately west of the river, the frequency of summer precipitation (May-September) increases to 50-60% in response primarily to an increase in the number of convective storms, and secondly, to the fact that winter fronts moving in from the Pacific Coast have much less effect in the rain shadow areas of the interior. Then, closer to the Coast Range, the coastal winter frontal weather becomes of more consequence, as much less of the precipitation

falls in the months May to September (Kleena Kleene 41.4% and Tatlayoko Lake 34.3%).

In close proximity to the Coast Range, significant increases in snowfalls and snowpack (Tables 1 and 2) are associated with the occurrence of the dry subzone of the Engelmann Spruce - Sub Alpine Fir.

To the northeast of the Fraser River, a significant precipitation gradient exists. The higher rain and snow amounts associated with cooler temperatures and a smaller moisture deficit, contribute to a substantial change in vegetation types. Much of the climate change occurs in very close proximity to and on the Quesnel Highlands. As a consequence, the lower regions of the Quesnel Lake area are within a wetter zone identified as the Interior Western Hemlock zone. Colder conditions in the north part of the district contribute to the commencement of the Sub-boreal zone.

A rapid precipitation increase is very apparent as one progresses northeast from Williams Lake; precipitation amounts are as follows: Williams Lake Airport 401.6 mm, 150 Mile House 425,5 mm, Horsefly R.S. 703.1 mm, and Barkerville 1263.7 mm. A part of this increase certainly is accounted for by the increase in elevation, and, in addition, the proximity to mountains. A significant increase in annual precipitation may be seen from Horsefly's 703.1 mm at 788 metres in elevation to Boss Mountain's 1263.7 mm at 1527 metres.

Much of the difference in annual precipitation between lowland and higher land occurs during the winter. Boss Mountain, for example, has only very slightly more precipitation during the months May-September. Thus, it is the snowfall which reflects a major part of the difference between the northeast part of the region and most of the remainder of the region. East of the Fraser River, snowpacks increase appreciably toward the highlands and mountains and at high elevations.

It is to be assumed that climate plays an important role in the distribution of vegetation. However, it is not so much one factor which is the limiting variable, but an interaction of a number of climate variables. Also, it is unlikely that the same climate parameters are responsible for the distribution of vegetation throughout the whole of the Cariboo Forest Region . Much more research is needed in this regard to discern these very complex and varied interrelationships. Additionally, many more stations are required in the Cariboo Forest Region .

TABLE 2. AVERAGE ANNUAL MAXIMUM MEASURED SNOWDEPTH FOR SNOW COURSE THROUGHOUT CARIBOO FOREST REGION

		Elevation in metres	Average Annual Maximum Measured Snowdepth in centimetres
SBS (a)	Big Creek	1140	36
	Puntzi Mtn.	940	39
ESSF (b)	Boss Mtn. Mine	1520	187
	Black Mtn.	1570	159
	French Snowshoe	1580	188
	Mount Timothy	1660	127
ESSF (a)	Tatlayoko Lake	1710	103

Water Investigations Branch,
Water Resources Service,
Snow Survey, 1935-1975

SOIL

All eight orders of the Canadian System of Soil Classification are represented in the Cariboo Forest Region, with some occurring more frequently than others.

Luvisols are the dominant soils occurring in six of the biogeoclimatic zones and subzones. Within the district Luvisolic soils occur on moderately coarse to fine textured parent materials at elevations between 600 and 1500 m.

Luvisols develop under forest or forest grassland transitions where temperatures are moderate to cool. They have surface Ae horizons in which silicate clay has been leached out (eluviation), and lower Bt horizons in which this silicate clay has accumulated (illuviation), (See Figure 12).

Podzols are the second most important group of soils in the Region. These occur on very coarse to medium textured parent materials in the wetter subzones of the Region, usually at elevations above 1000 m. The diagnostic horizon of these soils is a B_h, B_f or B_{hf} in which amorphous combinations of organic matter (where fulvic acid is more common than humic acid), Al and usually Fe are accumulated. These soils are acidic and generally have a low nutrient status. (See Figure 9).

Brunisolic soils are also fairly common in the region. These have soil horizons which are more highly developed than those of the Regosolic order, but lack the extent or types of horizon development specified for soils of the other orders. The diagnostic horizon for these soils is a Bm or Btj. These soils occur most frequently on dry sites at lower elevations and are also common in the higher elevations of the dry ESSF (a) subzone.

Chernozemic soils occur in the warmer and drier portions of the region, generally below 750 m in elevation (often higher on south facing slopes) and are characteristic of grassland communities. These soils have a dark-colored surface (Ah, Ahe, or Ap) horizon and a B or C horizon, or both and have a high base saturation. The dark-colored surface horizon is a result of decomposed organic matter, much of which is derived from the roots of grasses and forbs. These soils are generally productive, especially where water is not a limiting factor.

Four other soil orders occur locally in the region but do not form a major component of the landscape.

Regosolic soils are young soils which have had insufficient time for horizon development to take place. Where A and B horizon development has occurred it is insufficient to meet the requirements of other soil orders. These soils occur on parent materials of recent origin such as river deposits.

Gleysolic soils develop under wet conditions and conditions of permanent or periodic reduction. They most frequently occur along drainage tracts or other areas where the soil is wet during much of the growing season. These soils have low chromas, or prominant mottling, or both, in some horizons. (See Figure 10).

Organic soils develop on sites which are saturated for most of the year and are formed as a result of the accumulation of dead organic matter. Under anaerobic conditions the rate of accumulation is greater than the rate of decomposition. Physiologically these soils are often low in available nutrients.

Solonetzic soils are developed mainly under grass or grass - forest vegetation cover in semiarid to subhumid climates and are developed from saline parent materials.



Figure 8. Columnar basalt near the eastern regional boundary.



Figure 9. An Orthic Humo-Ferric Podzol. Note the white Ae and reddish Bhf horizons. Trout Creek area of the Interior Cedar-Hemlock zone.



Figure 10. . Mottling in a Gleysol, Abbot Creek.





MAPPING PROCEDURES

The field work consisted of recording the vegetational changes encountered throughout the Cariboo Forest Region. Access was gained mostly by road and only occasionally by helicopter and therefore many areas in the region were not visited. During the reconnaissance, notes were kept on the distribution of lesser vegetation and trees and this information was utilized in provisionally distinguishing the subzones. Map boundaries were mostly drawn on the basis of tree distribution since it was found that wherever there is a change in tree species distribution there usually was an accompanying change in the lesser vegetation and therefore in the mesic biogeocoenotic association. (See Figure 7, P.35 for map).

MAP BOUNDARIES

The lower boundary of the ESSF (a) subzone follows the 1525 metre (5000 ft.) contour while the lower boundary of the ESSF (b) subzone follows the 1220 metre (4000 ft.) contour. These boundaries were determined primarily on the basis of several ground checks, however, it is known that they vary according to local conditions. For example, as the climate becomes wetter to the west the subalpine boundary becomes lower. Both coastal zones, the MH zone and the CWH zones, because of the lack of access, were delineated through the use of aerial photographs, forest cover maps and after consulting persons familiar with the area. Similarly the AT zone, because of the lack of access, was delineated through the use of aerial photographs and forest cover maps and these were correlated to the few ground checks which were made. The IDF (a) subzone was delineated by a combination of ground checks, aerial photographs and forest cover maps. The remaining zones and subzones were delineated primarily on the basis of ground checks and extrapolations between these known points. Additional checks were also made from forest cover maps.

Within the Cariboo Forest Region there occur a few areas which are not representative of the zone or subzone in which they occur. Such anomolies occur as a result of unique environmental conditions or as a result of edaphic conditions which approximate conditions of other zones or subzones and in some cases may be considered as inclusions. The moderating effect which large lakes have on the climate is one example of such a situation. River valleys also have major effects on local climate.

It should be noted here that, for the most part, elevations noted in this report represent average conditions and that variations must be expected on the ground, especially where cold air drainage and aspect are major considerations. It is also very important to note here that this map was derived from information collected at a reconnaissance level for an area of the province where very little ecological base data has been collected and for this reason some of the lines on the map will undoubtedly need to be revised as more detailed ecological information becomes available.


SBS$_b$
SBS$_c$
SBS$_a$
IWH$_b$
ESSF$_b$
IWH$_a$
IDF$_a$
IDF$_b$
ESSF$_a$
AT
IDF$_c$
PPBG

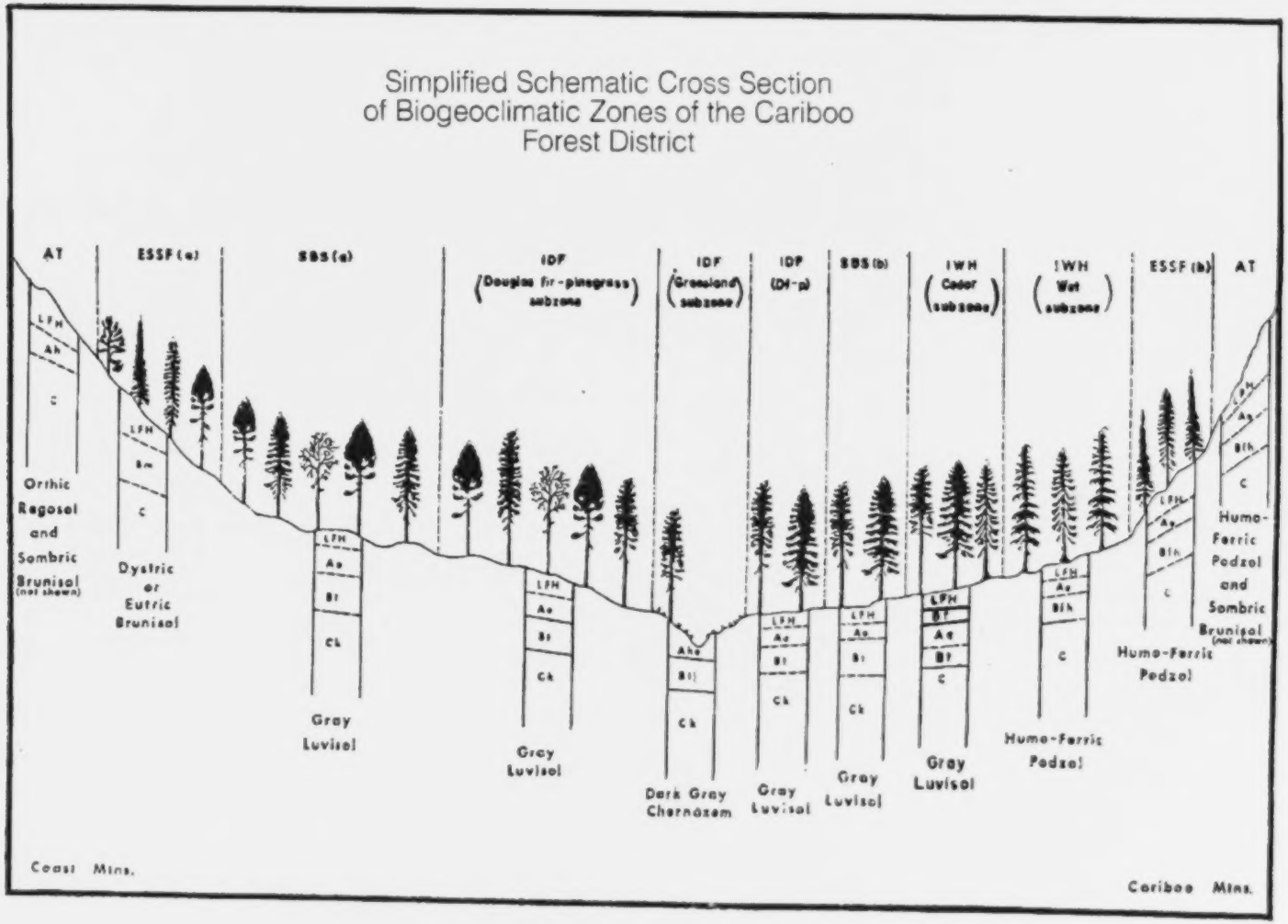

Simplified Schematic Cross Section
of Biogeoclimatic Zones of the Cariboo
Forest District
AT
ESSF (a)
SBS (a)
IDF (Douglas fir-pinegrass subzone)
IDF (Grassland subzone)
IDP (DF-p)
SBS (b)
IWH (Cedar subzone)
IWH (Wet subzone)
ESSF (b)
AT
Orthic Regosol and Sombric Brunisol (not shown)
Dystric or Eutric Brunisol
Gray Luvisol
Gray Luvisol
Dark Gray Chernozem
Gray Luvisol
Gray Luvisol
Gray Luvisol
Humo-Ferric Podzol
Humo-Ferric Podzol
Humo-Ferric Podzol and Sombric Brunisol (not shown)
Coast Mtns.
Cariboo Mtns.

Fig 14.

CHANGES IN ZONATION FROM KRAJINA'S ORIGINAL MAP

A major change from Krajina's zonal classification is proposed for the former Cariboo aspen-lodgepole pine-Douglas fir biogeoclimatic zone (CALPDF) as described by Krajina (1969) and his later modification, the Cariboo aspen-lodgepole pine zone (CALP) with its two subzones (Krajina, 1976).

In his latest proposal, Krajina (1976) divided the Cariboo zone into a northern subzone where white spruce is climax and a southern subzone where Douglas fir is climax, arbitrarily making the break at a latitude of 53°N. However, Krajina (1969) already pointed out that similarities exist between his northern Cariboo subzone and the sub-boreal zone to the north. Additional similarities between the southern Cariboo subzone and the interior Douglas fir and ponderosa pine-bunchgrass zones to the south were also mentioned. Krajina has therefore been aware of the transitional nature of his Cariboo zone and its heterogeneous habitats and ecosystems.

On the basis of the additional information gathered in this survey, it would appear to be more appropriate to consider the northern subzone of the CALP as a subzone of the Sub-boreal spruce zone (SBS) and the southern subzone as a part of the Interior Douglas fir zone (IDF). This proposed elimination of the Cariboo (CALP) as a distinct zone will better fit the criteria of homogeneity for defining a biogeoclimatic zone.

According to our definition, a biogeoclimatic zone has basically similar patterns of energy flow, biogeochemical cycling, vegetation, and soils as a result of a broadly homogeneous macroclimate. The Cariboo aspen-lodgepole pine zone is broadly heterogeneous in all the above respects.

To cite extremes, biogeocoenotic associations vary from those characterized by grasslands with Chernozemic soils (as found in the grassland subzone of the IDF) Fig. 15 to dense spruce forests with heavy moss layers on Bruisolic soils (the white spruce-subalpine fir-Douglas fir subzone of the SBS). These varied conditions, which all result from different macroclimates, can be found in the former CALP zone.

The following brief discussion is intended to indicate the climate, soil and vegetational characteristics which were used to justify the elimination of the CALP as a distinct biogeoclimatic zone.

Boreal climates are characterized by severe cold microthermal continental climates. Most of the area considered by Krajina to be the northern subzone of the CALP has a severe climate although a moderating maritime influence probably exists in the western part of this subzone. Additionally, the climate is milder in a belt along the Fraser River. The number of days during which frost occurs may be used as one example of the severity of the climate in parts of the Cariboo zone. For example, the number of days with frost in Kleena Kleene and Anahim Lake is greater than that of Watson Lake in the boreal forest of the Yukon Territory. Both Kleena Kleene and Anahim Lake average over 258 days of frost per year while Watson Lake has only 228.[1] Even Fort St. John and Fort Nelson which occur in the Boreal white and black spruce biogeoclimatic zone east of the Rocky Mountains have fewer days with frost than these areas in the Chilcotin. An extreme example of the severity of the climate in the Chilcotin is represented in the data from the Alexis Creek/Tautri Creek station which has an average of 277 days of frost per year.

The vegetation in the Chilcotin pine subzone of the SBS, reflects this cold macroclimate, especially in the wetlands that often show patterned fen development which is so characteristic of northern boreal forest. It appears that Douglas fir cannot tolerate the cold climate and therefore it is essentially absent from the Chilcotin pine subzone except under special edaphic conditions. White spruce is considered as the theoretical climatic climax tree in this subzone, however, frequent fires in the past have obscured this trend to the extent that lodgepole pine now covers much of the area and in fact could be conceived of as either an edaphic or "climatic" fire climax.

White spruce is one of the most characteristic trees of the Canadian boreal forests, essentially occurring across the northern forests of the continent. On this basis alone, it may be assumed that any area climaxing in white spruce will show affinities to the boreal forest. Black spruce, although limited in distribution, is another boreal tree species found in the Chilcotin pine subzone. When considering the climate and vegetation, future studies may indicate that the Chilcotin pine subzone fits the classification better as a subzone of the boreal forest rather than the sub-boreal forest as treated here.

[1] Number of days of frost per year - Data acquired from Environment Canada, 1970 and Kendrew and Kerr, 1955.



Figure 15. The grassland subzone of IDF in the Gang Ranch area of the Fraser Canyon.

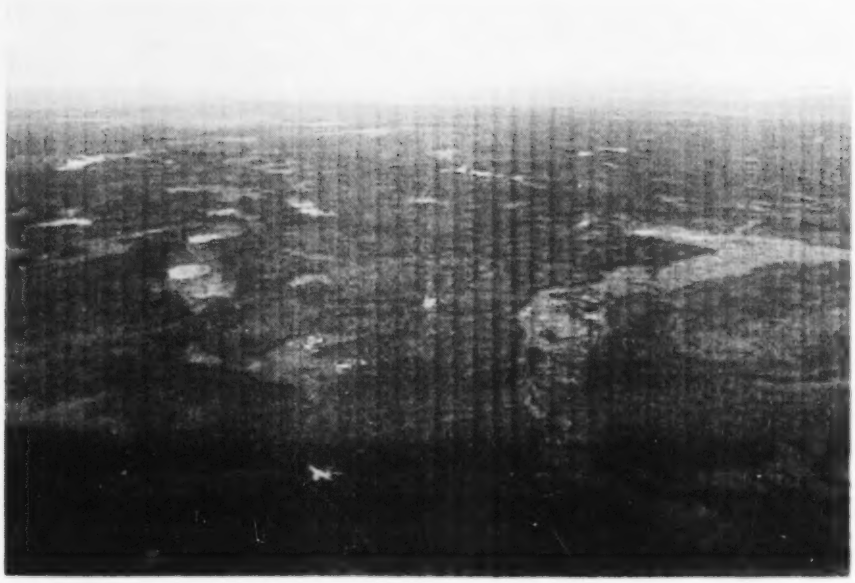


Figure 16. The Ponderosa pine subzone of the SBS in the Chilcotin area west of Williams Lake.

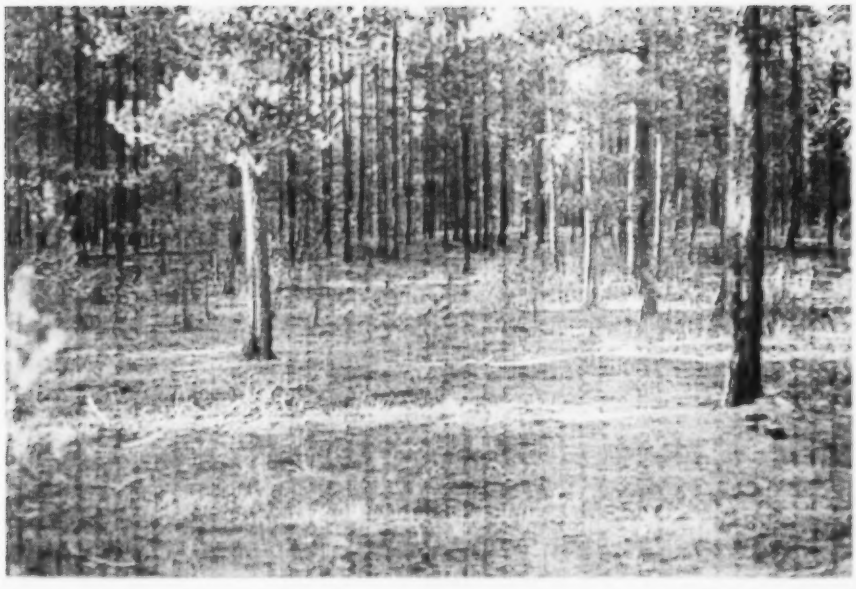


Figure 17. The Chilcotin pine subzone of the SBS showing a lodgepole pine - *Arctostaphylos* - lichen site type described by Illingworth and Arlidge (1960).



Figure 18. The Douglas fir - pinegrass subzone of the IDF showing a lodgepole pine-ashen pinegrass community. Although only small lodgepole pine and aspen are visible in the understory, this area will likely be a Douglas fir climax community.

The Douglas fir-white spruce subzone of the SBS has a milder climate than the Chilcotin pine subzone and also is much wetter. Additionally vegetation reflects transitional characteristics to the IDF and Interior western hemlock zone (IWH) as well as to the White spruce-subalpine fir-Douglas fir subzone of the SBS. The main criteria for placing the Douglas-fir-white spruce subzone into the SBS zone is the fact that white spruce is the dominant climax species on mesic sites with Douglas fir being only a successional species.

The rest of the former CALP zone is considered to belong to the IDF zone. Beil (1969) points out the affinities that his study area around Williams Lake has towards the IDF farther to the south in the following statement:

> "The forested areas show greatest similarity to the Douglas-fir Biogeoclimatic Zone (Krajina 1965). The grassland areas of the Chilcotin valley are very similar to those to the south in the Thompson and Nicola valleys as described by Tisdale (1947)."

If one compares the mesic plant association of the dry subzone of the IDF as described by Krajina (1969) with the mesic plant association described by Beil (1969) for the Williams Lake area it becomes apparent that the two are essentially variations of the same plant association. Both climax associations are generally dominated by *Arctostaphylos uva-ursi*, *Calamagrostis rubescens* and *Pseudotsuga menziesii*.

Both McLean (1969) and Brayshaw (1970) describe similar plant associations occurring farther to the south in the IDF zone. However, ponderosa pine which is absent in the Williams Lake area is often a seral species in these associations. On the basis of such similarities in vegetation on mesic sites between the Cariboo and IDF zones it appears unjustifiable to separate the Cariboo region from the rest of the IDF on a zonal basis. For this reason, where the mesic climax plant association is dominated by Douglas fir and pinegrass *(Calamagrostis rubescens)* in the Cariboo region, these areas are considered as a Douglas fir-pinegrass subzone of the IDF.

Likewise, the similarities of the grasslands of the Chilcotin and Fraser River valleys with grasslands farther to the south in the Thompson and Okanagan Valleys do not justify their separation on a zonal basis, especially since *Agropyron spicatum* is considered to be the major dominant climax grass species in both areas. Additionally, Chernozemic soils characterize these grasslands areas which shows that the two areas are closely related.

The individual characteristics of the subzones of the former CALP zone are discussed later as subzones of the SBS and IDF.

Table 3. Estimates of the distribution of timber productivity classes (CLI) by ecological zone in the Cariboo Forest Region.

Abstracted by A. Vyse

Biogeoclimatic subzone	Total Land M Hectares	Timber Productivity[3] 1	2	3	4	5	6	7
					%			
IWH (b)[1]	220.2		10	70	20	-	-	-
SBS (c)	284.9		10	40	30	20	-	-
IWH (cedar)	168.4			30	50	20	-	-
SBS (b)	582.8			20	60	10	-	10
ESSF (b)	699.3			10	20	30	20	20
IDF (b)	2,072.0				20	50	20	10
SBS (a)[2]	2,900.8				20	40	20	20
ESSF (a)	751.1					20	50	30
IDF (c)	67.3					10	50	40
IDF (grassland)	194.3						30	70
Others (AT, MH, CWH, PPBG)[1]	533.5							
Major Lakes	77.7							
TOTAL	8,522.3							

1. Very little of these zones have been rated for timber productivity.
2. Timber productivity in the S and W of this zone is much lower than in the N and E portions.
3. CLI ratings for Forest Capability based on gross merch volume at culmination age. Class = >110 cf/yr, Class 2 = 90-110, Class 3 = 70-90, Class 4 = 50-70, Class 5 = 30-50, Class 6 = 10-30, Class 7 = <10. Source: Interpretive Manuscripts, Capability for Forestry, Resource Analysis Branch. Ministry of Environment, Victoria, B.C.

PART III

BIOGEOCLIMATIC ZONES AND SUBZONES OF THE CARIBOO FOREST REGION

R.M. ANNAS, R. COUPÉ, W. WATT, J. HILTON, M. BEETS, J. PINKERTON

ALPINE TUNDRA – AT

The alpine tundra zone, because of its topographic location, experiences the most severe climate of all the zones in the Cariboo Forest Region . Generally it occurs at elevations above 2000 m (6500 ft.), however, in certain instances the AT occurs as low as 1800 m (6000 ft.).

VEGETATION

The most severe limitations with respect to plant growth are the severity of winters and the short growing season. Trees can become established at the lowest elevations of the AT, but invariably are of a twisted and flattened (krummholz) form due to snow damage and poor growing conditions. The only tree species occurring in this zone are subalpine fir *(Abies lasiocarpa)*, whitebark pine *(Pinus albicaulis)*, lodgepole pine *(Pinus contorta)* and Engelmann spruce *(Picea engelmannii)*. Amabilis fir *(Abies amabilis)* and mountain hemlock *(Tsuga mertensiana)* may occur in krummholz form in the alpine adjacent to coastal zones.

The shrub layer is also poorly developed in the AT. Only the most hardy species are able to tolerate the existing conditions. The most frequently occurring shrubs are *Salix* spp. and *Juniperus communis*. Many species of willow are dwarfs less than 10 cm tall, which is an adaptation to the harsh environment.

The AT is perhaps best known for its variety and richness of herbaceous flora and plant communities. In general, various species of *Compositae* as well as *Lupinus* spp., *Dryas* spp., *Saxifraga* spp. and various species of grasses and sedges inhabit drier sites. Wetter sites are inhabited by such moisture requiring species as *Ranunculus eschscholtzii, Parnassia fimbriata, Viola glabella, Valeriana sitchensis, Anemone occidentalis, Caltha leptosepala,* as well as various species of *Castilleja,* grasses and sedges.

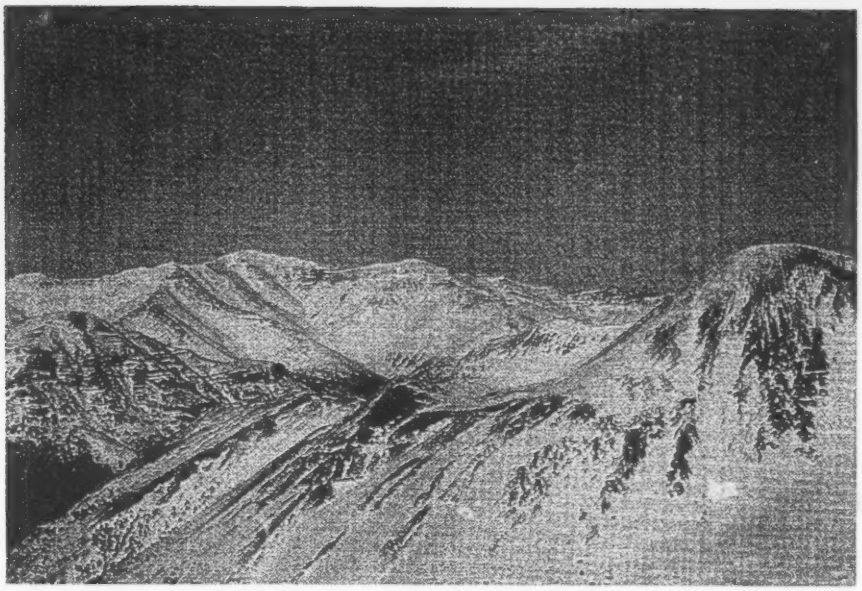


Figure 19. Windswept slopes in the AT provide winter habitat for big game. Ilgachuz Mountains.

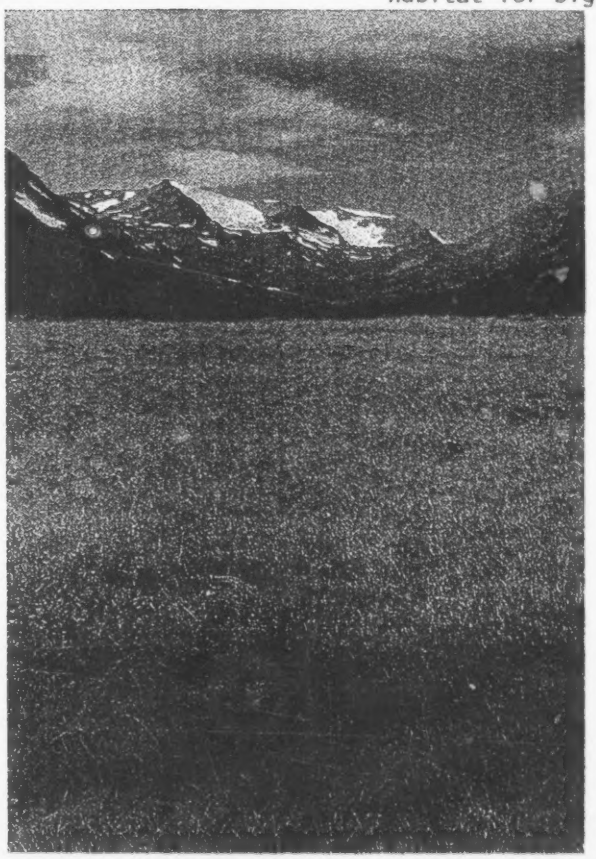


Figure 20. Rangeland at the ESSF (a)-AT boundary in Tosh Creek Valley (S.W. part of district).

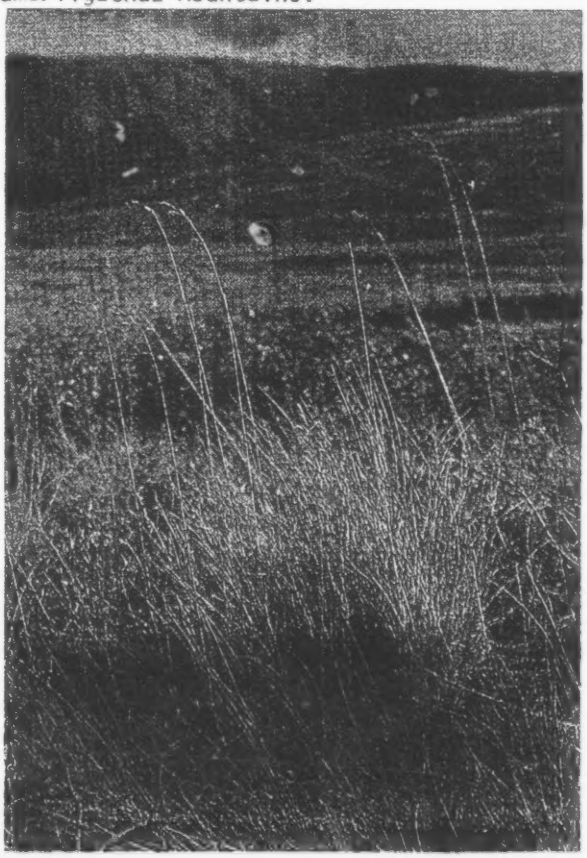


Figure 21 Excellent range conditions. Upper middle branch Nadila (Porcupine) Creek.



Figure 22. Lodgepole pine "pygmy" forest in the dry subzone of the ESSF. Perkins Peak south of Kleena Kleene.



Figure 23. The dry subzone of the ESSF. Note the effect of aspect. Forest productivity is generally low throughout the ESSF (a)

Varied plant communities with distinct boundaries are often found in small adjacent areas as a response to the sharp differences in environmental conditions such as depth and duration of snowpack.

Some variation was observed in the frequency of dry and wet ecosystems between the western and eastern mountain ranges. Generally the alpine between the Marble Range and the main Pacific Range have characteristically drier ecosystem environments than those occurring in the alpine of the Quesnel Highland or Cariboo Mountains. This is due largely to the corresponding climatic differences.

SOIL

Unique and interesting soils occur in the AT because of the active periglacial[1] processes. Active landscapes, where soil materials frequently flow or creep downslope or are churned as a result of freeze-thaw cycles, are common. Also, in steep rocky terrain these freeze-thaw processes are responsible for creating tallus slopes. Where these processes are frequent, soil horizonation or development is retarded. In areas where the landscape is more stable, soils are better developed. In the alpine of the Columbia Mountains, Podzolic soils are present on the less geomorphically active sites.

A general characteristic of the soils of the AT zone is that they are very sensitive to disturbance due to the active geomorphology of the soil environment.

RANGE

The AT zone in the eastern portion of the region has had little if any grazing by domestic livestock. The most extensive use of this zone is in the southwestern portion of the district where livestock have access to some of the most palatable and nutritious forage species such as fescues *(Festuca* spp.*)*, alpine timothy *(Phleum alpinum)* and a variety of sedges and forbs.

[1] Periglacial - Refers to areas, conditions and deposits in climatic areas where frost processes dominate.

WILDLIFE

The AT is of considerable importance to wildlife. Mountain goat, mountain caribou, California bighorn sheep, grizzly bear, black bear as well as some smaller game animals utilize the zone to a certain degree.

Because of deep winter snows, most ungulate use of the AT is restricted to the summer season at which time a wide variety of preferred forage species are available. Some portions of this zone, however, are windswept in winter which exposes the vegetation. These areas can support wintering populations of mountain goat, mountain caribou, bighorn sheep and moose. The AT is of little importance to waterfowl although upland game birds, such as ptarmigan are present.

Disturbance of this zone by cattle grazing, mining and general road access can have a major impact on wildlife. Consideration for proper protection of these areas is one of the critical problems of wildlife management in the region.

ENGELMANN SPRUCE-SUBALPINE FIR - ESSF

Each of the following two subzones could be further subdivided into additional subzones. One variant occurs at lower to mid elevations of its respective subzone and is occupied by more or less continuous forest. The second variant occurs at the uppermost elevations of its respective subzone and, as a result of severe climatic conditions, is inhabited by clumps or patches of trees of very poor growth and form. This variant is often referred to as the subalpine parkland.

ESSF (a) SUBZONE

The Engelmann spruce-subalpine fir (a) subzone occurs on the leeward side of the Coast Mountains as well as on the Camelsfoot, Marble, and Chilcotin Ranges to the south; and on the Ilgachuz, Itcha, and Rainbow Ranges to the north. At elevations greater than 1525 metres (5000 ft.), the ESSF (a) is found above either the Interior Douglas fir zone or the sub-boreal spruce zone. The cold dry climate, as well as limiting species occurrence, results in low biological productivity for the zone.

VEGETATION

Lodgepole pine, a tree capable of existing under a great variety of environmental conditions, is the most common tree in the ESSF (a). The abundance of this species is undoubtedly related to the large moisture deficit during the growing season and the resulting frequency of past wildfires. Although lodgepole pine is generally considered a successional species, it may form a component of the climax community on drier sites in this subzone (as well as in other zones in the district). Whitebark pine, subalpine fir, and Engelmann spruce are also common in the ESSF (a), the latter two being the climax species on mesic and wetter sites.

Because of the ESSF (a)'s drier climate, the lush understory vegetation which is characteristic of the ESSF (b) subzone (and the MH zone), is restricted to drainage tracts in this subzone. The poorly developed understory vegetation of the ESSF (a) is, for the most part, composed of plants which tolerate a large moisture deficit, a short growing season, and severe winter conditions.

Juniperus communis and *Shepherdia canadensis* are the two most common shrubs. The shrub layer is generally poorly developed. The herb layer, which is slightly better developed, often contains *Vaccinium scoparium*, *Lupinus* spp., *Empetrum nigrum*, *Pedicularis* spp., *Arctostaphylos uva-ursi*, *Arnica cordifolia*, and various grasses. Lichens are also very prevalent in this subzone.

The western part of the ESSF (a) in the Pacific Ranges of the Coast Mountains represents an area transitional to the coastal subalpine zone. Scattered mountain hemlock, for example, are found in the subalpine above the western side of the lower part of Chilko Lake. The subalpine above Tatlayoko Lake, as well as that above the western side of Chilko Lake, has a much wetter climate than that described for the ESSF (a). In the future this area will need to be studied and probably will be separated as a distinct subzone.

SOIL

Brunisolic soils characterize the ESSF (a) subzone. These soils commonly occur on sloping, often steep, topography and are represented on a large variety of elevational and aspect conditions. They are generally moderately coarse with moderately low water holding capacity. This, along with a dry climate, results in soil moisture deficits during the growing season.

Many of the soils of this subzone show evidence of leaching by the presence of a discontinuous leached surface mineral horizon (Aej). Leaching, which moves the soluble salts lower down in the soil profile, into the B horizon, also increases the acidity of this horizon. These soils are classified as Degraded[1] Dystric Brunisols. Soils which have formed on calcareous parent materials in the ESSF (a), such as those in the Marble Range, generally have a high pH and base status and are classified as Eutric Brunisols.

On colluvial or alluvial deposits, where the accumulation is very recent or still active, Regosolic soils occur. These soils, because of their young age, express very weak morphological characteristics and are without a diagnostic (distinguishing) B horizon. As a result of low precipitation, weathering is very shallow and weak in the ESSF (a) subzone compared to the ESSF (b).

RANGE

The grazing potential of the ESSF (a) varies with the extent and distribution of ecosystem types. Some sites are valuable productive range sources but for the most part the understory vegetation is of limited value to livestock. Logged areas in this subzone can be very productive and useful, from a cattle raising point of view, depending on the method used to harvest the timber. The increased forage production may be of short duration due to rapid canopy closure by trees and shrubs.

WILDLIFE

Moose, mule deer, mountain goat, mountain caribou, California bighorn sheep, grizzly bear, black bear, wolves and cougar are all present in the ESSF (a). Although deep snow is a significant limiting factor, the subzone is utilized moderately heavily by moose and mule deer in summer and fall before the animals migrate to lower elevation winter ranges. Mountain goat and bighorn sheep occur in limited numbers throughout much of the ESSF (a), especially in the summer in the vicinity of the AT zone. Good numbers of mountain caribou are supported by the area of the Itcha-Ilgachuz-Rainbow Mountain Ranges. Grizzly and black bear are present throughout the ESSF (a).

[1] Degraded = Eluviated

The ESSF (a) receives only limited use by waterfowl in the summer and fall. Lakes and potholes are usually frozen when nesting occurs in the spring. Upland game birds commonly found in the subzone are ptarmigan and grouse.

Disturbance in ESSF (a) subzone by activities such as mining, logging and cattle grazing can have a major impact on wildlife. Although no logging has occurred in this subzone, poor distribution of livestock and mining exploration access roads have created problems for wildlife. Fragile plant communities in this subzone often need long recovery periods when disturbed.

SILVICULTURAL CHARACTERISTICS

Lodgepole pine, Engelmann spruce, subalpine fir and to a lesser extent whitebark pine are the major tree species in the ESSF (a) subzone. Because of the frequency of past wildfires, even-aged lodgepole pine stands are the most common forest cover type. Natural regeneration of lodgepole pine is generally good providing there is sufficient mineral soil exposure to provide an adequate seedbed.

The overall forest productivity, relative to the other zones and subzones of the region, is quite poor (see Table 3 p.43). Some of the silvicultural problems presently associated with the ESSF (a) include high susceptibility of subalpine fir to heart rot through logging scars, infrequent seed years in Engelmann spruce, high incidence of cone and seed insects, and rust in spruce cones.

ESSF (b) SUBZONE

The ESSF (b) occurs primarily east of the Fraser River below the AT zone at elevations greater than 1200 m (4000 ft.). The subalpine of the Telegraph, Nechako and Fawnie Ranges have been included in the ESSF (b) as well as the higher elevations of the Nazko area west of the Fraser River. More detailed studies are required on these subalpine areas west of the Fraser River since they may more appropriately belong to a slightly drier subalpine subzone. Generally, the ESSF (b) occurs above the IWH and the SBS biogeoclimatic zones in the Cariboo Forest Region. Plants requiring relatively high soil moisture levels are abundant in the ESSF (b) due to the ample precipitation during the growing season which is supplemented by meltwaters from heavy snowpacks.

VEGETATION

Subalpine fir and Engelmann spruce, which are both capable of tolerating frozen ground, thrive best in a moist environment. They are the characteristic and most dominant trees of the ESSF (b) subzone. At the lower elevations of the ESSF (b), hybrid white and Engelmann spruce are common. Lodgepole pine is generally restricted to drier sites, becoming established after a disturbance such as fire. This is in contrast to the ESSF (a) subzone where lodgepole pine generally forms extensive stands on mesic sites throughout the subzone.

The shrub layer is often very well developed with the more frequent shrubs being *Rhododendron albiflorum, Menziesia ferruginea, Vaccinium ovalifolium, V. membranaceum, Alnus crispa, Ribes lacustre,* and *Oplopanax horridus.* The herb layer, which is often very well developed, commonly contains *Valeriana sitchensis, Viola glabella, Gymnocarpium dryopteris, Streptopus roseus, Cornus canadensis* and *Rubus pedatus.*

Under closed canopy conditions, a dense carpet of mosses often develops. *Pleurozium schreberi, Ptilium crista-castrensis, Hylocomium splendens, Rhytidiadelphus triquetrus* and *Dicranum* spp. are the most commonly occurring moss species. At the higher elevations in the parklands, heather communities are very common.

Webb (1976) has described five forested plant associations from the MacKay watershed in the Quesnel Highlands.

SOIL

In this subzone, soils are formed on a variety of parent materials. Soil parent materials include morainal, colluvial and glacial fluvial deposits as well as weathered bedrock. These materials may be mixed or occur singly. Podzolic soils generally develop on morainal, glacial fluvial and stable colluvial materials. Regosolic soils are often found on the less stable colluvial materials.

Soils in the ESSF (b) subzone tend to be cooler than those of the IWH zone. However, the organic layer remains shallow. This indicates that soil temperatures remain warm enough for sufficient periods to cause considerable decomposition of organic matter.

More detailed studies of vegetation and soil have been undertaken in this subzone by Webb (1976) and Smith *et al.*, (1975).

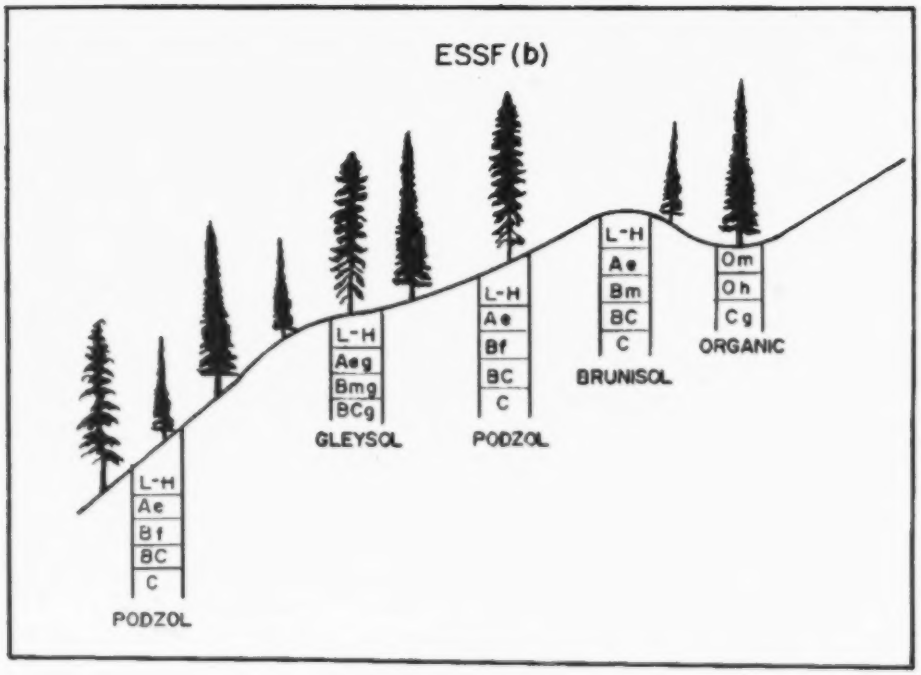


Figure 24.

The mountainous topography prevalent in this subzone poses a number of management concerns. A major concern is the cutting of skid roads on slopes resulting in soil disturbance through an interception of seepage and an acceleration of erosion. The net effect is a reduction of site quality and a concentration of runoff along roadways causing erosion downslope. The usually moist conditions of medium textured soils during the summer months create difficulties to road construction as well as limitations to timber harvesting by conventional tracked or rubber tired vehicles.

RANGE

Historically, the ESSF (b) has not contributed significantly to the supply of forage for domestic grazing.

WILDLIFE

Mountain caribou, mountain goat, moose, mule deer, grizzly bear and black bear are common in this subzone. Cougars and wolves also occur in limited numbers.

Snow is a major limiting factor to ungulates, although snow depths vary considerably within the subzone. For example, snow depths in the Cariboo River area seem to be much less than in the Quesnel Lake area.

Most big game use takes place in summer and fall, although mountain goat and mountain caribou are present throughout most of the year. Because of snow conditions mountain caribou generally exhibit two yearly migrations from lower to higher elevations. Deep fluffy snows force them to lower elevations in late fall. When the snow hardens the caribou are forced down once again. Old growth forests and especially timber stands with heavy growths of tree lichens (epiphytes) provide necessary winter habitat for mountain caribou while the numerous small semi-alpine meadows provide summer and fall habitat for caribou and bears. The ESSF (b) subzone is similar to the ESSF (a) subzone with respect to waterfowl and upland game bird use.

Past human activity has been minimal in this subzone, however, this is rapidly changing. Logging and mining activity are areas of major concern to wildlife managers due to the problems associated with increased human access and the removal of old growth timber. Mountain caribou, mountain goat and grizzly bear are the first to be affected by human activity.

SILVICULTURAL CHARACTERISTICS

Engelmann spruce and subalpine fir are the major commercial tree species of the ESSF (b). In general the potential for forest productivity in the ESSF (b) is high relative to the other subzones of the region (except for the IWH). Many forest stands are mature or overmature, with the latter often having a significant amount of decay.

Problems associated with obtaining regeneration include light and infrequent seed years in spruce and the inability of seedlings to tolerate temperature extremes and periods of drought. At the higher elevations in the ESSF (b) serious regeneration problems can be expected due to the heavy prolonged snow cover. Wherever the present high elevation stands have a clumped distribution of trees, prolonged regeneration delays are to be expected due to heavy snowpacks. Other silvicultural problems which occur in the ESSF (b) are the lack of windfirmness of Engelmann spruce and subalpine fir in some areas and the susceptibility of subalpine fir to heart rot.



Figure 25. ESSF (b) subzone. Alder thickets such as these are important wildlife habitats. Areas which have clumped distribution of trees will be difficult to regenerate following logging.



Figure 26. Engelmann spruce-subalpine fir forests in the Omineca Mountains, Mackay River area.

MOUNTAIN HEMLOCK - MH

Because of the lack of access into this part of the region, , this zone as well as the CWH zone were not examined on the ground. Within the Cariboo Forest region the MH zone has a typically high elevation coastal climate with high annual precipitation, milder winters and heavier annual snowfall than the interior subalpine zone. Mountain hemlock, amabilis fir, subalpine fir as well as minor amounts of western hemlock inhabit this zone. Because of the close proximity of this zone to the ESSF (a) subzone, the MH zone in this area contains elements of both zones.

COASTAL WESTERN HEMLOCK - CWH

The CWH zone which is under the influence of a coastal climate contains such trees as western hemlock, western red cedar, amabilis fir and minor amounts of western white pine. Forest cover maps indicate that spruce and Douglas fir are also present. The proximity of this zone to the IDF (b) subzone suggests that the CWH zone will be of an interior transition variety.

RANGE

Neither the MH or CWH have contributed significantly to the range resource; and future use is doubtful. Soil, wildlife, and silvicultural characteristics are not discussed for these zones.

INTERIOR WESTERN HEMLOCK - IWH

The interior western hemlock biogeoclimatic zone is broken down into two subzones in the Cariboo Forest region . The wet subzone (IWH (b)) corresponds more or less directly to the IWH (b) subzone described by Krajina (1969). The drier part of the IWH in the Cariboo (the IWH (cedar) subzone) is substantially different from Krajina's dry IWH (a) subzone which was originally described from studies done further to the south (see Bell, 1964). It is difficult to place the cedar subzone into any of the established biogeoclimatic zones since it is a transition or ecotone area between the subzones of the boreal forest to the west and north, and to the wetter subzone of the IWH to the east.

IWH (CEDAR) SUBZONE

The cedar subzone is placed in the IWH biogeoclimatic zone even though western hemlock is absent (a few scattered individuals occur locally). Precipitation (over 70 cm per year) is greater in the IWH (cedar) subzone than in the sub-boreal zone to the west and falls within the limits set by Krajina (1969) for the IWH biogeoclimatic zone. Additionally, many species characteristic of the IWH zone are present in the cedar subzone. These characteristics show the affinities that the cedar subzone has towards the IWH, although many other characteristics are similar to sub-boreal forests.

VEGETATION

Western red cedar, white spruce and Douglas fir are the main tree species in the cedar subzone with the first two being the dominant climax species on mesic sites. Lodgepole pine, paper birch *(Betula papyrifera)*, black cottonwood and aspen *(Populus tremuloides)* are also frequent.

Under an open canopy the shrub and herb layers are often well developed. Some of the common shrubs include *Acer glabrum*, *Pachistima myrsinites*, *Rubus parviflorus* and several *Vaccinium* spp., *Rubus pubescens*, *Cornus canadensis*, *Pyrola secunda*, *Lycopodium* spp. are often dominant herb species. Generally, a well developed moss layer is present, especially under a closed canopy.

SOIL

The transitional or ecotone characteristics of the IWH (cedar) are reflected in the soils as well as in the vegetation. The common modal soil development is towards Luvisol-Podzol intergrades (Brunisolic and Podzolic Gray Luvisols, and Luvisolic Podzols). Soils formed on medium textured glacial till parent materials will usually have a weathered brown to reddish-brown surface mineral horizon (occasionally overlain by a shallow discontinuous grayish white Ae horizon). Underlying this brown weathered horizon at a depth of 30 to 65 cm is a brownish, dense, blocky structured, clay-enriched Bt horizon. Seepage sites and depressional areas with imperfect to poor drainage have gleyed subgroups of the modal soils as well as Gleysolic soils.

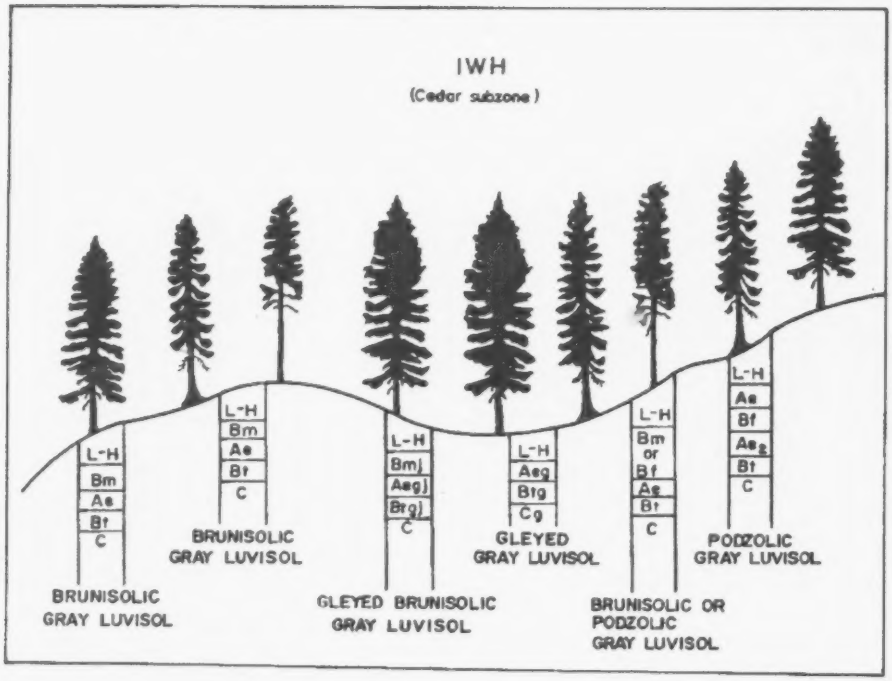


Figure 27.

In general, the soils of this subzone are reasonably productive and nutrient cycling is moderately rapid indicated by relatively thin litter layers. The surface mineral soil is low in organic matter and nitrogen. Thus, the nitrogen regime is drastically lowered by scalping the litter layer or by severe burning. Also, the surface soil, when moist, will compact under traffic.

RANGE

The IWH (cedar), in the past, has not significantly contributed as a grazing source. Recently, some of the logged over areas have been seeded with range seed mixtures and should provide some valuable summer grazing. The rapid rate of succession to the shrub and tree stages, however, makes these logged areas only temporarily available for grazing.

WILDLIFE

Moose, mule deer, bear, cougar, and wolf are the main wildlife species present in the IWH (cedar) subzone. Browse production is generally good throughout the subzone. The area contains numerous moose as well as some mule deer winter ranges. Snowfall, which limits the usefulness of winter ranges for ungulates, varies throughout the subzone, especially with elevational

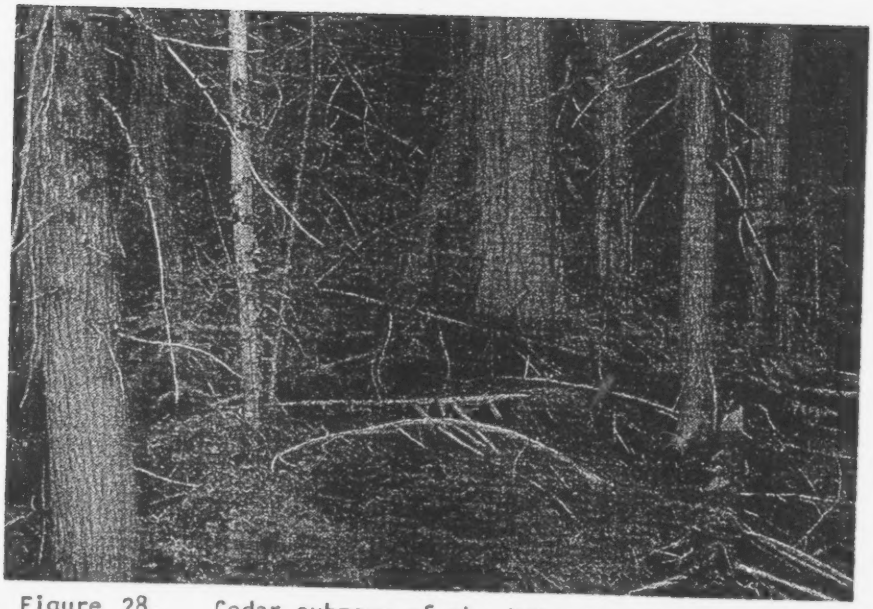


Figure 28. Cedar subzone of the IWH near Likely

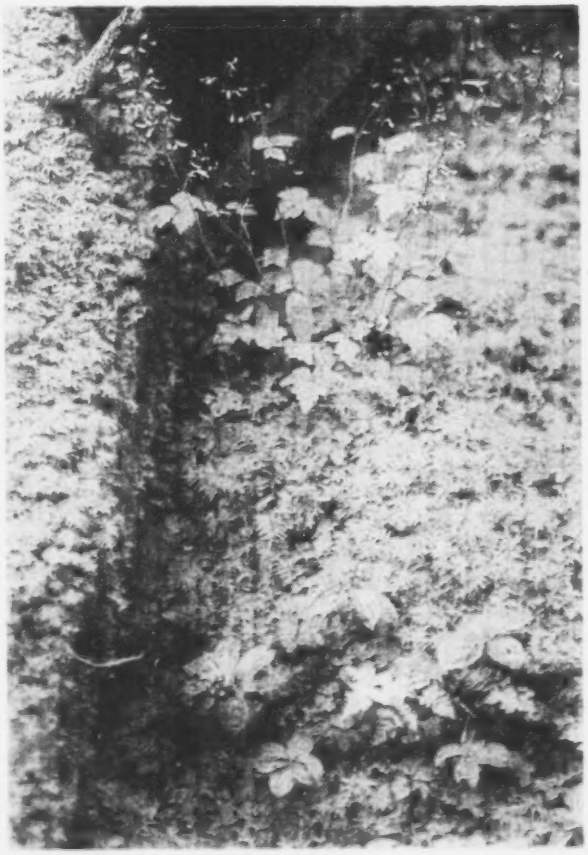


Figure 29. Old growth western red cedar in a seepage site in the IWH (b) subzone above the North Arm of Quesnel Lake.



Figure 30. Circummesic site in the IWH (b) on the south side of Horsefly Lake. Trees are Douglas fir, western hemlock and western red cedar.





differences. For example, the area around Likely, which has less snow than the higher elevation Bosk Lake region, is the more valuable area as moose or deer winter range.

Dense cedar stands in this subzone generally offer little in the way of ground vegetation as food for wildlife, however, their heavy canopy intercepts large quantities of snow making movement easier for wildlife during the winter. Presently, the IWH (cedar) is treated the same as the IWH (b) subzone by wildlife managers and one of their main concerns is maintaining suitable habitat diversity.

Furbearers seem to be abundant in the IWH (cedar) and past records have shown it to be a key area for lynx. Ruffed grouse and Franklin grouse are the main upland game birds in the subzone.

SILVICULTURAL CHARACTERISTICS

The major commercial trees of the ecotone are western red cedar, white spruce, Douglas fir and lodgepole pine. The IWH (cedar) is the third most productive biogeoclimatic unit in the district. The ecotone is silviculturally somewhat similar to the IWH (b) except for the absence of western hemlock. The planting of spruce and Douglas fir mixtures is not presently practiced since it is believed to produce favourable conditions for the spruce gall aphid.

IWH (b) SUBZONE

The wet subzone of the IWH lies east of the Fraser River and primarily in the Quesnel Highland at elevations less than 1200 m (4000 ft.). Future studies in the Pacific Ranges may reveal that some of the coastal transition areas such as that found at the south end of Chilko Lake, will more properly fit in with the interior western hemlock biogeoclimatic zone.

VEGETATION

Heavy winter snowpack, which prevents the ground from freezing, and relatively high growing season precipitation allow western hemlock to successfully compete with most species in the IWH (b). Since western hemlock is the most abundant tree species in the subzone and since it is very shade tolerant, it forms the climax tree species on mesic sites.

The most common trees of the IWH (b) are western red cedar *(Thuja plicata)*, western hemlock *(Tsuga heterophylla)*, white spruce *(Picea glauca)*, Douglas fir, lodgepole pine and black cottonwood. Western yew *(Taxus brevifolia)* was observed to occur sporadically in the IWH (b).

Where the forest canopy is sufficiently open, the shrub and herb layers are well developed. The most common shrubs are *Pachistima resinites*, *Vaccinium ovalifolium*, *V. membranaceum* and *Rubus parviflorus* with *Oplopanax horridus* being prevalent on seepage sites. Herbs common to this subzone include *Cornus canadensis*, *Linnaea borealis*, *Rubus pedatus*, *Tiarella trifoliata* and *Gymnocarpium dryopteris*. Also *Lysichitum americanum* occurs infrequently in this zone on wet sites.

Where the canopy is sufficiently closed on mesic sites a nearly continuous carpet of mosses occurs. The most common of these being *Hylocomium splendens*, *Pleurozium schreberi*, *Rhytidiopsis robusta* and *Ptilium crista-castrensis* with the lichen *Peltigera aphthosa* also being common.

SOIL

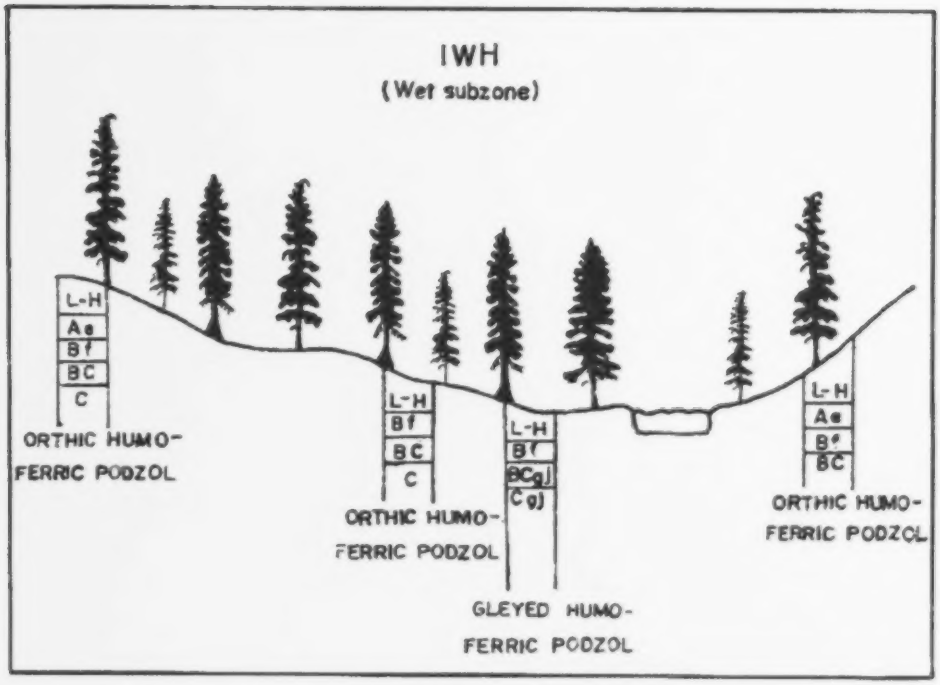


Figure 33.

The soil moisture regime is high and therefore moist soils are maintained throughout the year. This environment is ideally suited to the development of Podzolic soils. In general, the organic litter layer decomposes rapidly to maintain a dynamic equilibrium with the continuous addition of organic matter in the form of litterfall (ie. needles and branches). In the Podzolic soils, organo-metallic oxides are translocated from the surface mineral horizons into the B horizon to form a rich Bf horizon with an organic matter content ranging from 3 to 10 percent. Characteristics such as these alter the surface soil properties markedly from that of the parent material.

When moist or wet, these Podzolic soils have low shear strengths and low bearing strengths. As a result, roads must be cut down into the parent material and are locally difficult to drain. Most timber harvesting is attempted in winter except where the parent materials are coarse textured and gravelly. Heavy conventional logging equipment is generally not suitable for use on moist sites during the growing season. Mechanized site treatment can cause excessive soil disturbance, especially when soil moisture content is high and alternative treatments such as slashburning on moist sites cause less environmental damage.

RANGE

The potential of the IWH (b) for grazing prior to and following logging is similar to that of the adjacent ESSF (b) subzone. It does not at the present time contribute significantly to the production of domestic cattle forage in the region.

WILDLIFE

Moose, mule deer, mountain caribou, grizzly bear, black bear, mountain goat, wolf and cougar are major wildlife species of the IWH (b). The relatively low snowfall (as compared to the ESSF (b)) and good browse production have created some excellent moose and mule deer winter ranges. The Cariboo River winter moose range of the IWH (b), for example, is the best winter range in the region. The exception seems to be the Matthew River where past inventory information has shown this area to receive relatively little winter use due to heavy snowfall.

Portions of the IWH (b) are known to be early winter ranges for mountain caribou and it is suspected that some pockets of cedar are also used. One known mountain goat range also occurs in this subzone.

Portions of the IWH (b) are excellent for waterfowl, including both ducks and geese. Ruffed grouse and Franklin grouse are the main upland game birds. Furbearers seem to be plentiful in the IWH (b) with upland as well as aquatic species being present.

Considerable logging and wildfires have occurred in the IWH (b) and the key to continued use of this zone by wildlife is habitat diversity. If future logging methods can maintain a continuous supply of food and cover for wildlife species, the IWH (b) should remain as one of the more important areas for wildlife in the Cariboo Forest Region.

SILVICULTURAL CHARACTERISTICS

The main commercial tree species of the IWH (b) subzone are western hemlock, western red cedar, white spruce, lodgepole pine and Douglas fir. Hemlock is the most shade tolerant of these species while lodgepole pine and Douglas fir are the least shade tolerant. In terms of timber production the IWH (b) is the most productive in the region. Many of the stands in this subzone are, however, mature or overmature with both hemlock and cedar exhibiting a very high level of heart rot.

In general slashburning on mesic or drier sites in areas of high precipitation can result in serious site degradation through loss of nutrients and organic matter. On such sites in the IWH (b) one can expect that slashburning, which removes much of the surface organic matter, will increase the rate at which nutrients are leached from the soil thereby lowering the productivity of the site. Additionally, burned sites are more susceptible to surface erosion by water. Slashburning on wetter seepage sites, however, generally has little effect on their nutrient status since these sites are continuously being supplemented by nutrients from seepage waters. Also the organic matter content which supplies many of the essential nutrients is often higher on wetter sites and the burn is generally not as intense as on drier sites.

Other silvicultural problems associated with this zone are: brushing in following logging, poor quality residual stands, the severe environmental conditions following logging and burning and the effect these have on regeneration.

SUB-BOREAL SPRUCE – SBS

The SBS is the largest biogeoclimatic zone in the Cariboo Forest Region. The concept of the SBS zone has been broadened from that originally proposed by Krajina (1965, 1969) and described by Revel (1972) and Wali and Krajina (1973). The broadening of the concept of the SBS zone (and the IDF zone) was necessitated by the elimination of the Cariboo aspen-lodgepole pine as a distinct biogeoclimatic zone as was discussed earlier. The SBS as presented here consists of three subzones: the Chilcotin pine subzone (SBS (a)), the Douglas fir - white spruce subzone (SBS (b)) and the white spruce-subalpine fir - Douglas fir subzone (SBS (c)).

SBS (a) SUBZONE

The Chilcotin pine subzone lies entirely west of the Fraser River and is for the most part in the rainshadow of the Coast Mountains. The SBS (a) has the most severe climate of any of the zones in the Cariboo Forest region which occur below the subalpine. The cold climate results in a relatively low productivity for both forest and range resources.

VEGETATION

The relatively cold dry climate of the Chilcotin pine subzone prevents the establishment of many plant species characteristic of the IDF zone. White spruce, the theoretical climax species and lodgepole pine are the only dominant conifers capable of tolerating the environmental conditions as they exist in this subzone. Black spruce, a boreal species, is found in bogs in the northern portion of the zone. Douglas fir is generally absent from the Chilcotin pine subzone except on habitats where the severe climate is compensated for by special edaphic factors. Aspen and black cottonwood are the main deciduous trees occurring in the zone.

Illingworth and Arlidge (1960) describe a lodgepole pine - *Arctostaphylos* - lichen site type which is the characteristic plant association of mesic to dry sites in the Chilcotin pine subzone. *Shepherdia canadensis*, *Juniperus communis* and *Rosa acicularis* (of poor vigor) are the common shrubs on these mesic to dry sites. The shrub

layer becomes very well developed only along the edges of wet depressions, and along stream and lake edges. Here *Betula glandulosa* and *Salix* spp. often form thick entanglements.

The herb layer is generally poorly developed in all but the wetter habitats. *Arctostaphylos uva - ursi, Antennaria* spp., *Solidago spathulata* and *Fragaria virginiana* are the most frequently occurring herbs on mesic forest sites. Pinegrass is variable in cover in the Chilcotin pine subzone and although it may be moderately abundant on moister sites, it generally has a diffuse sparse growth over much of the area. Wetter communities are often entirely composed of sedges with the resulting sedge meadows being very common and extensive throughout the subzone. Many species of lichens, especially species of *Cladonia, Peltigera* and *Stereocaulon,* are very common on mesic to dry sites.

SOIL

The most common soils are Luvisols which have developed on moderately coarse to medium textured morainal blankets which are found on much of the gentle rolling topography of the Fraser Plateau in the Chilcotin area. Generally, the organic litter layer is shallow and the soil organic matter content is low. The soil climate regime of this subzone is very cold and dry, thus short periods of drought may occur during the growing season. Forest productivity is low largely due to the short cool and relatively dry growing season.

RANGE

A combination of soil, climate and possibly repeated wildfires appear to be the main reasons why the Chilcotin pine subzone has one of the least productive understories for livestock forage in the Cariboo region. Pinegrass (*Calamagrostis rubescens*) is sparse and never forms the productive pinegrass communities which are so characteristic of the IDF zone. Less productive species such as sheep fescue (*Festuca ovina*), ricegrass (*Oryzopsis asperifolia*) and in some cases reindeer lichen (*Cladonia* spp.) are the dominant forage species. Stocking rates over much of the subzone may reach 4 to 6 ha (10-15 acres) per animal unit per month. A very significant range resource of the area are the large sedge meadow complexes which are important grazing sources as well as sources of hay for winter feeding.



Figure 34. An *Arctostaphylos* - lichen community in the Chilcotin pine subzone of the SBS.



Figure 35. White and black spruce surrounding a sedge meadow in the Nazko area. Forest productivity is highest in the western part of the subzone (SBS (a)).

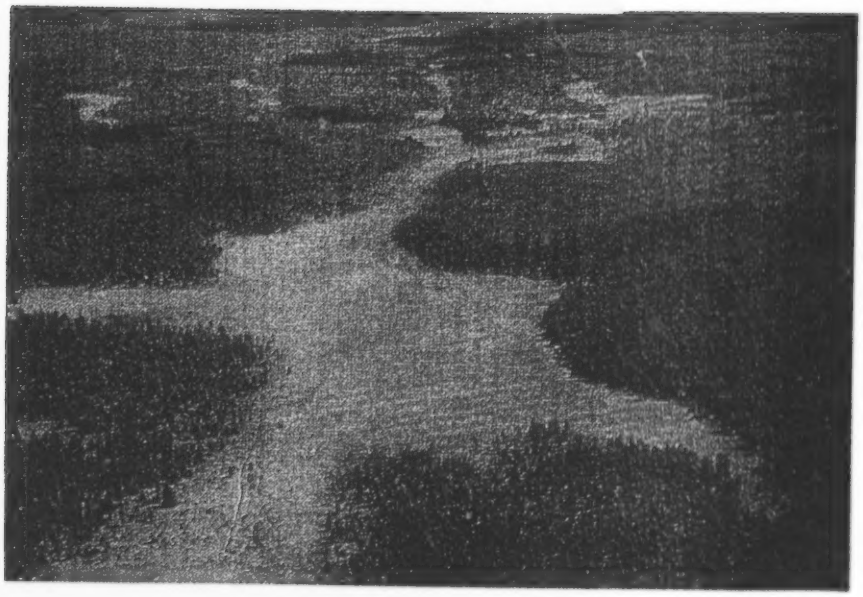


Figure 36. A sedge meadow in the Chilcotin pine subzone. The open forest canopies of adjacent *Arctastaphylos* - lichen communities are clearly visible.



Figure 37. Sedge meadows similar to this one near Anahim Lake provide the most significant range resources of the Chilcotin pine subzone.

WILDLIFE

Moose, mule deer, mountain caribou, black bear, grizzly bear, wolf and cougar are big game species which occur in the Chilcotin pine subzone.

The abundance of good forage plant species in wetlands and along water courses throughout the subzone creates excellent summer range for moose. Although snow is a limiting factor in winter for ungulates over much of the Chilcotin pine subzone, some winter ranges do occur at lower elevations along the main valleys. However, the large stands of lodgepole pine (the lodgepole pine - *Arctostaphylos* type of Illingworth and Arlidge (1960)) which are so common throughout the subzone supply little feed for big game.

The Chilcotin pine subzone contains many habitats normally suitable for waterfowl, however, climate is a limiting factor, especially in the western portion of the subzone where open water is not available until late in the spring due to the cold climate. Other wildlife species include grouse which are fairly frequent and the furbearers which generally require aquatic habitats.

Although human population is relatively sparse in the Chilcotin pine subzone, ranching practices (draining swamps, cutting brush and poor livestock distribution) could reduce the value of the area for wildlife in the future.

SILVICULTURAL CHARACTERISTICS

Generally, the Chilcotin pine subzone of the SBS has a low productivity in comparison with other subzones of the Cariboo. The major commercial trees of this subzone are lodgepole pine and white spruce. The silviculture of the extensive lodgepole pine forests is predominantly dictated by four factors: the even-aged nature of the stands which have generally developed from wildfires, the pioneering ability of the species, the preponderance of mistletoe within the stands and the serotinous nature of lodgepole pine cones.

When logging occurs in these pine stands it is essential that a sufficient number of cones be left scattered over the area to provide sufficient seed for the establishment of the next crop. Present pine stands tend to be overstocked due to prolific seeding which occurs following wildfires. The relatively low productivity does not allow for economic thinning in the foreseeable future.

Silvicultural problems associated with this subzone vary from a lack of serotiny in lodgepole pine cones in some areas necessitating the leaving of seed trees or planting, to the need of large clearcuts to minimize the area of regeneration susceptible to mistletoe infection from the perimeter stand and problems created by the mountain pine beetle which has reached epidemic proportions in some areas.

SBS (b) SUBZONE

The Douglas fir - white spruce subzone of the sub-boreal spruce biogeoclimatic zone represents an ecotone area between the interior Douglas fir zone to the south, the wetter interior western hemlock zone to the east and the more typical sub-boreal forests to the north which have been described by Revel (1972) and Wali and Krajina (1973). Precipitation is greater in the SBS (b) subzone than in the IDF zone to the west which is reflected in the vegetation. White spruce is considered to be the theoretical climatic climax species of the Douglas fir - white spruce subzone.

VEGETATION

Douglas fir, white spruce, lodgepole pine and aspen are the most common tree species. Paper birch, although not overly abundant, is considered a characteristic species for this subzone. The shrub layer is often very well developed in the SBS (b) subzone. Characteristic shrubs include *Rubus parviflorus, Pachistima myrsinites, Acer glabrum, Spirea betulifolia* and *Vaccinium myrtilloides.*

Pinegrass, which is a diagnostic herb for much of the IDF zone, occurs with low abundance in the SBS (b). Some of the more common herbs are *Aralia nudicaulis, Cornus canadensis, Aster* spp., *Linnaea borealis, Calypso bulbosa* and *Vaccinium caespitosum.* The herb layer is often very well developed, especially on the moister sites of the SBS (b). The moss layer generally becomes well developed on most sites as the forest stands approach climax. As of yet, no ecosystem studies have been carried out in the SBS (b) subzone in the Cariboo Forest Region.

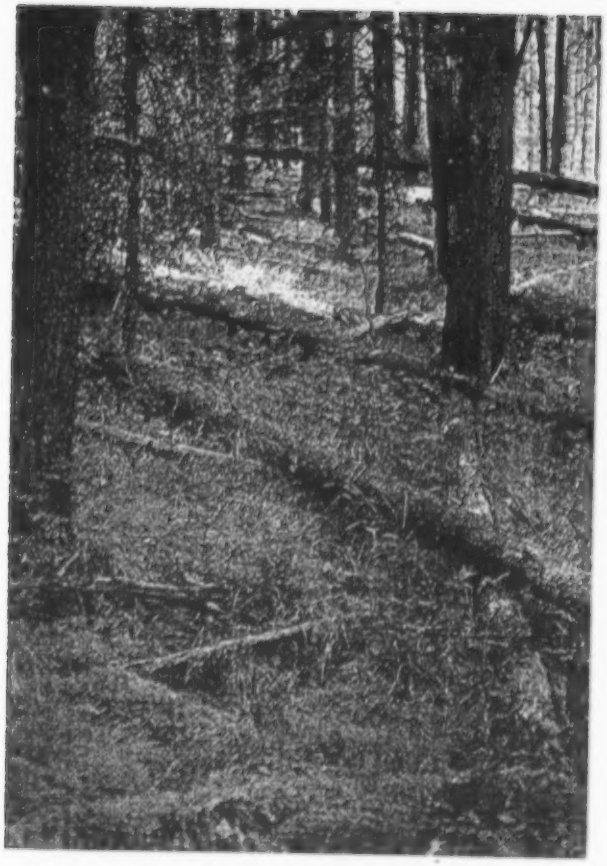


Figure 38. A lodgepole pine - *Calamagrostis* - moss community with a white spruce shrub layer in the SBS (b) north of McLeese Lake.

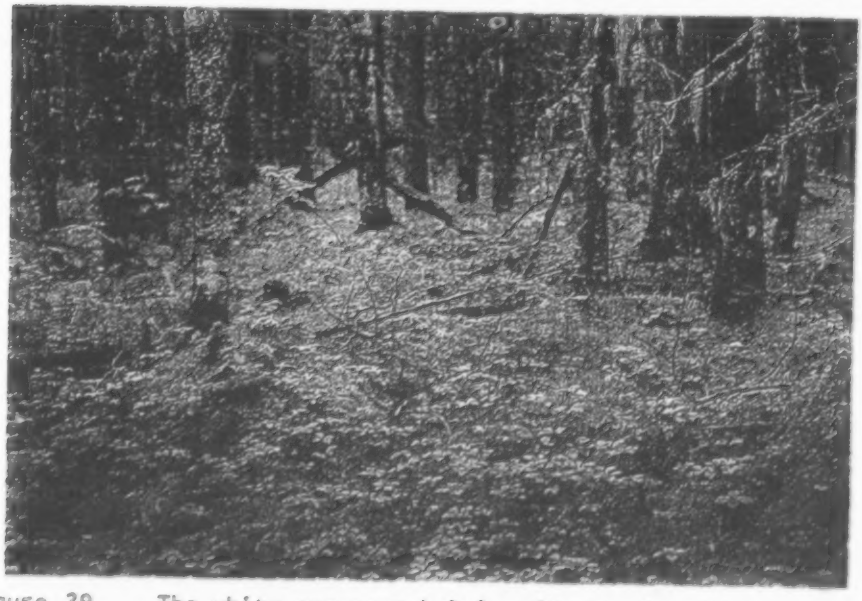


Figure 39. The white spruce-subalpine fir-Douglas fir or SBS (c) subzone north of Quesnel showing a circummesic community.

SOIL

Most of the soils within the SBS (b) subzone are Gray Luvisols but have developed under slightly different climatic conditions than those of the SBS (a) or IDF zones to the west since increased precipitation tends to moderate temperature extremes. Soils in both the Orthic and Brunisolic subgroups of the Luvisolic order are represented in the subzone. The mineralogy of the parent material is slightly different due to the influence of metamorphic rock types in the glacial till derived from the Quesnel Highland. The Bt horizon is somewhat deeper as the glacial till is not as clayey as that in the IDF zone.

Management considerations for these soils are similar to those of the Douglas fir-pinegrass subzone of the IDF. However, trafficability problems may be more prevalent due to the shorter growing season and relatively moister soils during the summer than in the adjacent IDF.

RANGE

The SBS (b) subzone is one of the most productive subzones in the district. The seral stages in the subzone are the most productive with forage being provided by a variety of wheatgrasses (*Agropyron* spp.) ryegrasses (*Elymus* spp.), bluegrasses (*Poa* spp.), and forbs such as peavine and vetch. The abundance of shrubs may often restrict the lower growing forage species but many of the shrubs are used by domestic livestock. Such shrubs include willows, thimbleberry (*Rubus parviflorus*) and red-osier dogwood (*Cornus stolonifera*).

WILDLIFE

Moose, mule deer, elk, bears, wolf and cougar are the major big game species of the SBS (b) subzone. This subzone supplies good browse production for ungulates, although moderately deep snow in winter is a limitation, especially for mule deer. The main mule deer winter ranges occur along the breaks of the Fraser River, Beaver Valley, Baker Creek and other select locations where mature stands of Douglas fir still remain. Moose can tolerate the deeper snows to a much greater extent and good winter ranges for moose occur along the main valleys, on wetlands and on south facing upland slopes.



Figure 40. The Douglas fir-white spruce or SBS (b) subzone on a slightly moister than mesic site.



Figure 41. A white birch stand in the SBS (b) subzone in a subhygric site. These stands have very well developed shrub layers.

The only elk in the region occur in this subzone. Present populations are small and their range is fairly isolated along the Quesnel River and Skelton Valley.

The subzone has excellent areas for waterfowl. Geese are numerous along the Fraser River and along the Horsefly River. Ruffed grouse are the most common upland game bird and both upland and aquatic furbearers are present in the subzone.

Land alienation on key wildlife areas, amount of logging, logging access and disturbance to wetlands are major activities affecting wildlife. As in the Douglas fir-pinegrass subzone of the IDF, the alienation and development of forest lands and wetlands for agricultural purposes is a major factor threatening prime moose winter range within the SBS (b).

SILVICULTURAL CHARACTERISTICS

The SBS (b) subzone is one of the most productive timber producing subzones in the district. The main commercial trees are Douglas fir, white spruce and lodgepole pine.

Reforestation through planting has had more success in the SBS (b) subzone than in the IDF zone to the west and may be attributed to the higher precipitation and less severe climate. Also blowdown appears to be more of a problem in the SBS (b) and is probably a result of the higher precipitation (shallower rooting system) and the taller stems.

SBS (c) SUBZONE

The white spruce - subalpine fir - Douglas fir subzone (SBS (c)) of the SBS zone has previously been described for areas north of Prince George by Revel (1972) and Wali and Krajina (1973). The SBS (c) subzone occurs in the northeastern portion of the district and is greatly influenced by a cold continental climate from the north. The climate of the SBS (c) is characterized by severe winters with heavy snowfall and cool moist summers.

VEGETATION

White spruce and subalpine fir are the characteristic tree species and are part of the climax community on mesic sites. Other tree species common to the SBS (c) include Douglas fir, lodgepole pine, aspen, paper birch and black cottonwood. Black spruce (*Picea mariana*) frequently occurs on poorly drained sites.

The understory vegetation of mature mesic sites is largely dominated by a nearly continuous carpet of mosses with few shrubs or herbs present. Wetter and richer sites or sites having more open canopy abound in shrubs and herbaceous species. The most common shrubs of the subzone include *Rubus parviflorus, Spiraea betulifolia, Acer glabrum, Vaccinium myrtilloides, Symphoricarpos albus* and *Rosa acicularis*. Herbs common to SBS (c) include *Aralia nudicaulis, Habenaria orbiculata, Rubus pubescens, Goodyera oblongifolia* and *Aster conspicuus*.

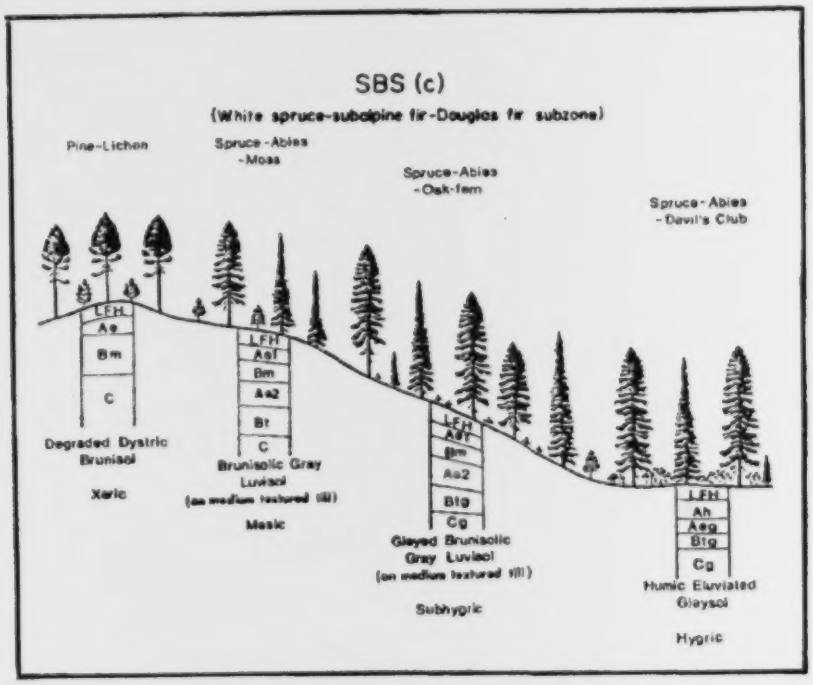


Figure 42.

SOIL

Soil parent materials of SBS (c) are commonly medium textured glacial tills on undulating topography. Modal sites on glacial tills are medium to slightly richer than medium in nutrients and support growth of white spruce which is among the best in the district. The majority of soils in the subzone are classified in the Luvisolic order. On seepage sites and depressional areas, a combination of cool temperatures and lush understory vegetation results in a thick organic litter layer on the mineral soil. Even though these sites have the higher potential productivity, natural regeneration of trees is often difficult as mineral soil exposures are minimal under natural stand conditions. Drier sites have shallow organic litter layers and conditions for regeneration are therefore, more favourable.

On a majority of sites the soils are moist during most of the growing season and conventional ground skidding often results in compaction and severe rutting on skid trails. Compaction on skid roads often contributes to reduced growth and survival of trees on these sites. Because mineral soil exposure is necessary for the adequate germination of spruce, harvested sites are often scarified. Conventional scarification may, however, result in nutrient depletion on microsites as a result of excessive scalping of organic matter. Winter logging reduces soil compaction and mineral soil exposure but necessitates post-logging silvicultural treatment for stand regeneration.

RANGE

In general, undisturbed areas in the SBS (c) subzone are of limited grazing value. Early successional stages such as those created through wildfires or logging, when on productive soils, can produce an abundance of forage, especially if improved forage species are seeded following the disturbance. These sites will remain productive forage areas until they are overtaken by more advanced successional stages.

WILDLIFE

Moose, mule deer, black bear, grizzly bear, and mountain caribou occur in the SBS (c) subzone. Known wildlife activity is limited although summer and fall use by ungulates occurs. Snow depths restrict winter use except in isolated locations. Two locations are known to be early winter range

for mountain caribou and some portions of the subzone are good fall range for moose.

Waterfowl are present along some of the lower elevations of the SBS (c) although overall the subzone is not exceptional for waterfowl. Grouse are present in limited numbers throughout the zone. Furbearers are present with most of the trapping occurring at the southern end of the zone.

Logging and placer mining are the two most common forms of human activity in the SBS (c) subzone. Placer mining often has a significant impact on fisheries, but may also be detrimental to other wildlife species since vegetation is often removed along water courses. Large areas of blowdown and subsequent salvage logging have created extensive clearcuts that are of minimal value to wildlife.

SILVICULTURAL CHARACTERISTICS

The SBS (c) subzone is second only to the IWH in terms of forest productivity in the region. The major commercial species are white spruce, subalpine fir, lodgepole pine and Douglas fir. Douglas fir is restricted mainly to the Fraser River and some of its larger tributaries where the climate is less severe.

Special silvicultural problems have developed from a history of large fires and extensive areas of blowdown. These two factors have resulted in very large openings, some in the magnitude of several thousand hectares. Silvicultural problems include the need to scarify to provide adequate seedbed and reduce brush competition on moist sites and the need to plant in large clearcuts to ensure adequate stocking and rehabilitation of residual stands.

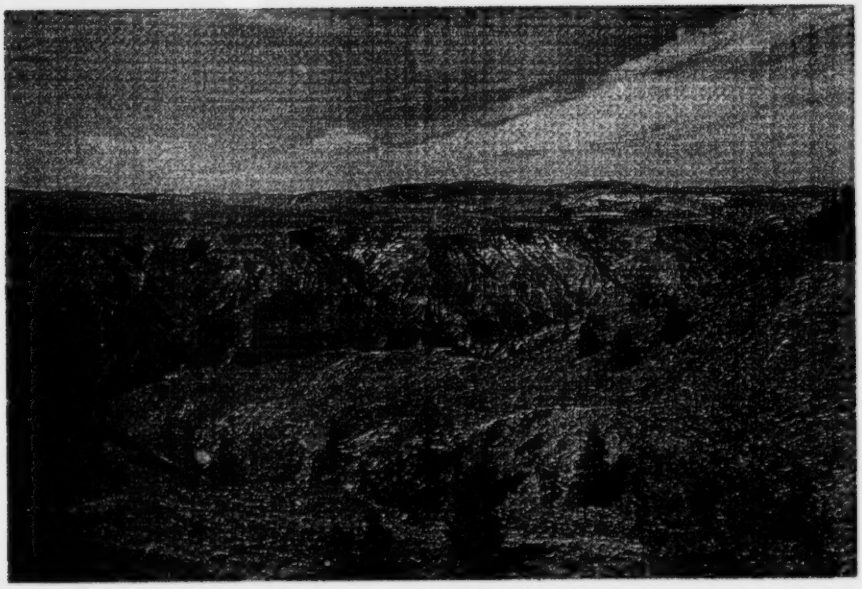


Figure 43. The grassland or IDF (a) subzone near Big Bar Ferry showing the Fraser Canyon. In the lower elevations of the subzone big sagebrush is common.



Figure 44. Higher elevations of the IDF (a) subzone south of Riske Creek.

INTERIOR DOUGLAS FIR – IDF

As mentioned earlier, the concept of the interior Douglas fir biogeoclimatic zone has been expanded to include all the areas which climax in Douglas fir on mesic sites. An exception to this statement is the lower elevations of the grassland subzone of the IDF which probably will always remain as grasslands. The exact position that the grassland subzone has in relation to other zones and subzones can only be determined after all the other grasslands in the southern part of the province have been studied and thoroughly compared.

IDF (a) SUBZONE

The grassland subzone of the IDF (IDF (a) subzone) generally occurs below 900 m (3000 ft.) and is centered along the Fraser and lower Chilcotin Rivers south of Williams Lake. This area has the warmest and driest climate of the entire forest region.

VEGETATION

The grassland subzone of the IDF is composed primarily of steppe (grassland) communities which is a response to the dry climate of the area. Although trees such as Douglas fir and Rocky Mountain juniper (*Juniperus scopulorum*) are present they are never very abundant. At higher elevations of the grassland subzone, lodgepole pine and aspen are also present. Ponderosa pine (*Pinus ponderosa*) which thrives in the semi-arid areas to the south is absent in the subzone due to the cold climate except in the most southern part where occasional trees are present. The lower elevations in the subzone (as described by Bell (1969)) show similarities to the Ponderosa pine-bunchgrass biogeoclimatic zone as described by Krajina (1969) and Brayshaw (1970) and to the *Artemisia tridentata* zone of Mclean (1969). One of the noteable differences between the grasslands in the Cariboo with those to the south is the general absence of *Festuca idahoensis* and *F. scabrella*.

The shrub layer of the IDF (a) is usually poorly developed with *Chrysothamnus nauseosus* and *Artemisia tridentata* being the two most common shrubs. The latter species often increases dramatically in abundance with overgrazing. Both of the above species are common in the drier parts of the IDF and in the PPBG zones to the south.

The herb layer is often well developed and is comprised chiefly of grasses. Bluebunch wheatgrass (*Agropyron spicatum*) is considered a diagnostic species for the subzone and forms a major component of the climax communities on mesic sites. On the most arid sites in the IDF (a) subzone, *Opuntia fragilis* and *Calochortus macrocarpus* are fairly common.

Two variations of the grassland subzone occur in the Cariboo Forest Region which can be separated on the basis of the presence or absence of lodgepole pine and aspen. The driest and warmest variation occurs primarily on the slopes and terraces above the Fraser and lower Chilcotin Rivers with lodgepole pine and aspen being absent. Climatic data from the climatology section of the Resource Analaysis Branch (Table 4) indicates that the lower elevations of the river valleys is substantially warmer during the growing season than the areas near the rim of the plateau. In these lower areas *Artemisia* is very common.

The Riske Creek-Big Creek area of the Fraser Plateau receives slightly higher precipitation and cooler summer temperatures. In this variation, aspen and lodgepole pine occur fairly frequently along with Douglas fir. There are indications that these grasslands at higher elevations are maintained in a sub-climax condition due to fire. The soils at the higher elevations of the subzone are Dark Gray Chernozems which indicate a closer relationship to forest soils than the Dark Brown Chernozems of the lower elevations.

Similar plant communities to those found in the grassland subzone can be found in isolated locations in other parts of the IDF zone such as through the San Jose Valley. These communities or ecosystem assocations are often found on steep south and southwestern exposures above lakes and stream valleys and on the fine textured soils of some valley bottoms. These conditions are considered to be a result of edaphic factors.

SOIL

Chernozemic soils are characteristic of this dry subzone with Dark Gray and Black Chernozems being most common. These soils develop under dominantly grassland vegetation in a distinctly arid environment. A dark coloured organic enriched surface horizon (Ah), high base status and an alkaline pH are characteristic properties of these soils. With

Table 4. Mean daily temperatures (°C) for various elevations of the Junction Range area above the Chilcotin River and for the Williams Lake Airport for 1969 and 1970.

Source: Climatology Section R.A.B.

Station Elevation	Year	January	February	March	April	May	June	July	August	September	October	November	December
Farwell 22 671 m (2200 ft.)	69	M	M	M	8.7	13.9	20.0	18.0	16.9	12.7	5.3	4.2	M
	70	-11.7	-2.7	2.1	11.8	12.1	18.7	20.9	19.9	11.8	6.4	-5.9	M
Farwell 25 853 m (2800 ft.)	69	M	M	M	7.2	13.6	19.8	18.0	15.9	12.7	5.6	2.8	M
	70	-13.2	-3.1	1.2	5.7	11.9	17.4	18.1	19.1	10.4	5.7	-6.0	M
Farwell 28 853 m (2800 ft.)	69	M	M	M	7.8	12.9	19.1	16.7	15.2	10.9	5.2	3.1	M
	70	-10.9	-2.4	0.7	5.1	9.8	16.9	18.8	18.7	10.1	4.9	-5.7	M
Farwell 31 918 m (3010 ft.)	69	M	M	M	7.1	12.4	19.8	16.4	15.5	11.6	5.6	-5.3	M
	70	-11.1	-2.5	0.4	4.4	9.9	16.5	18.0	18.1	9.7	5.3	-5.3	M
Williams Lake 926 m (3038 ft.)	69	-22.2	-5.7	0.7	6.0	10.1	17.1	14.4	13.2	10.2	4.1	1.8	M
	70	-11.0	-2.3	-0.5	3.2	8.3	15.0	16.3	16.1	8.4	4.4	-4.3	M

M - Missing

precipitation being low, very little leaching occurs. In a warmer and drier environment at lower elevations along the Fraser and Chilcotin Rivers, the terraced landforms have Dark Brown Chernozems developed on them while the upper elevations are characterized by Dark Gray Chernozems.

Many of the soils at lower elevations in this subzone are suitable for the production of agricultural crops providing the topography is suitable and water for irrigation is available.

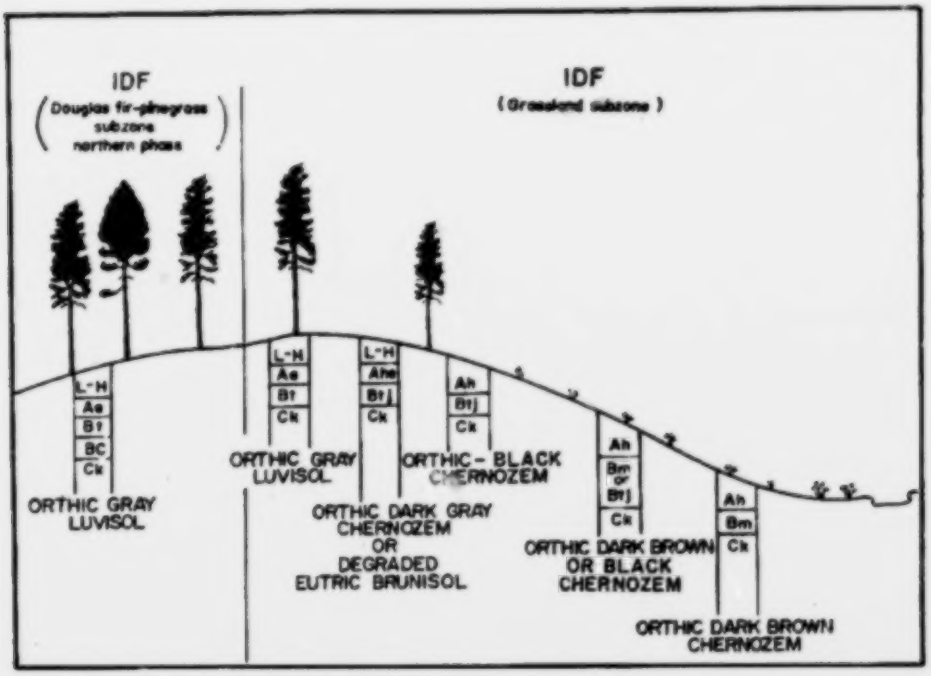


Figure 45

RANGE

The grassland subzone of the IDF has the largest concentration of grasslands in the region and consequently is the most significant area of forage production for domestic livestock.

Many of the range sites in this subzone are similar to those found farther south and include such herbage species as: bluebunch wheatgrass (*Agropyron spicatum*), needlegrass (*Stipa* spp.), big sagebrush (*Artemisia tridentata*) and rabbit-brush (*Chrysothamnus nauseosus*).

Being one of the lowest elevation subzones with many south facing slopes, the area contains some of the largest concentrations of early spring range. Most of the snow may be gone by March on the most southerly aspects.

Some of the most productive hay producing areas are also found in the grassland subzone. Good growing conditions, fertile soils and good water supplies enable some producers to attain three cuts of hay per year.

WILDLIFE

California bighorn sheep, mule deer, moose and black bear occur in this subzone. The low snowfall and the presence of preferred forage species adjacent to good escape terrain makes portions of this subzone ideal habitat for California bighorn sheep. The Junction sheep range, at the confluence of the Chilcotin and Fraser Rivers, is one of the most important California bighorn sheep ranges in North America. Approximately 40% of the present world's population of California bighorn sheep stem from a series of transplants from this range.

Mule deer are also present in the grassland subzone with most use occurring on the west side of the Fraser River in early spring.

Some of the best waterfowl potholes of the region occur in this subzone. Most species of ducks, as well as geese and swans utilize the area at some time during the year. Blue grouse, sharptail grouse and ruffed grouse are common. Chukar partridge in the extreme southern part and mourning dove are also present.

SILVICULTURAL CHARACTERISTICS

The grassland subzone has one of the lowest productivities in terms of timber production in the region. Virtually no logging is carried out in the IDF (a). Heavily limbed and twisted Douglas fir which are scattered on the steep slopes above the Fraser River make logging an uninviting proposition. Douglas fir in this subzone requires shade to become established on all but the wettest sites. Any site which is logged would present very difficult reforestation problems and almost invariably would revert to a grassland community for a long period of time.

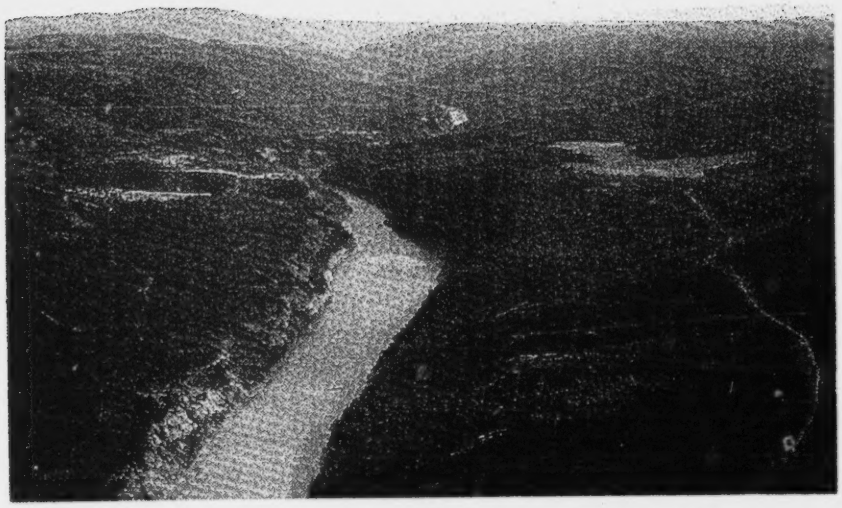


Figure 46. The Douglas fir - pinegrass or IDF (b) subzone of the IDF. Looking north along the Fraser River north of Williams Lake.



Figure 47. A Douglas fir - pinegrass community east of 100 Mile House.

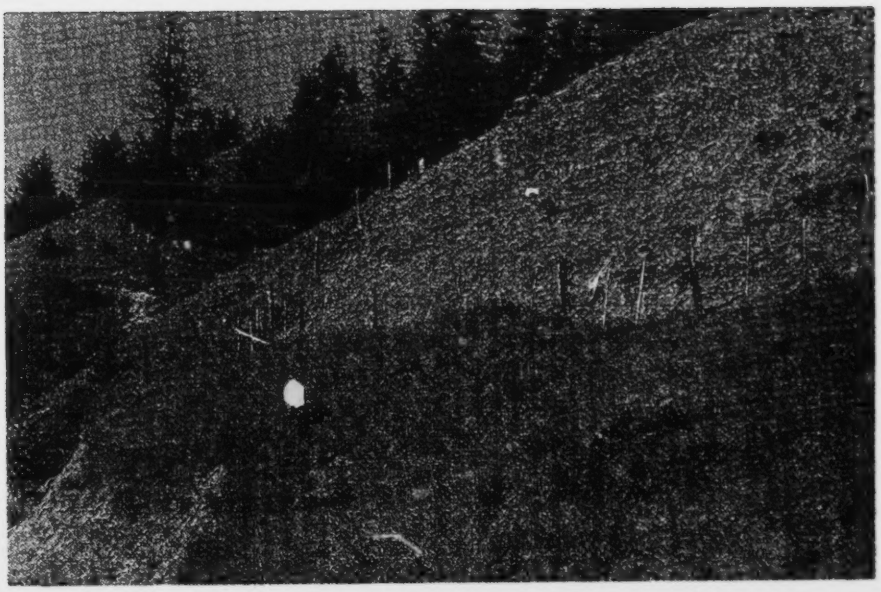


Figure 48. These xeric communities in the IDF (b) subzone show the effects of grazing and fencing on an *Agropyron spicatum* ecosystem association.



Figure 49. Winter range for mule deer in the Lac La Hache area of the IDF (b).

IDF (b) SUBZONE

The Douglas fir - pinegrass subzone (northern phase) or IDF (b) is the largest subzone of the IDF in the Cariboo Forest Region. The IDF (b) is restricted primarily to the Fraser Plateau which has a milder climate than the SBS zone. The milder climate of the IDF, due to the effect of the Fraser River Valley, is extended north of the boundary drawn on the map in a narrow strip following the Fraser River as far north as Quesnel.

VEGETATION

Douglas fir is the most diagnostic tree species for this subzone and forms the major forest component of climatic climax ecosystems. Other tree species occurring in the Douglas fir - pinegrass subzone include lodgepole pine, aspen, Rocky Mountain juniper, white spruce and black cottonwood. On moister sites paper birch can occasionally be found. Subalpine fir is also found in what is presently believed to be a wetter transitional phase of the IDF on the southeast side of Tatlayoko Lake and the west side of Chilko Lake. These areas are in need of further study to properly place them into subzones.

The most common shrubs of the Douglas fir - pinegrass subzone are *Rosa acicularis, Shepherdia canadensis, Salix bebbiana, S. scouleriana, Juniperus communis* and *Spirea betulifolia.* The generally well developed herb layer is dominated by pinegrass. Pinegrass is considered a characteristic species for the IDF (b) and exhibits its greatest abundance on mesic sites. Other common herbs include *Fragaria virginiana, Linnaea borealis, Arctostaphylos uva-ursi, Aster ciliolatus* and *Smilacina stellata.* The moss layer is generally poorly developed however on moist sites under a closed forest canopy it usually becomes well developed.

The Douglas fir - pinegrass subzone could possibly be further subdivided into two variations on the basis of the presence or absence of white spruce in the understory on mesic sites. White spruce occurs more frequently on mesic sites in the northeastern and eastern parts of the subzone where precipitation is slightly higher. However, white spruce is not expected to become a significant component of climax communities except in the transitional area between the IDF (b) and the SBS (b) subzones. *Salix* spp. and *Vaccinium* spp. are additionally more abundant on mesic sites in the northeast of the IDF (b) while *Astragalus miser* is absent. The northeastern parts of the subzone appear to have a higher productivity than the rest of the subzone due to higher moisture. Even though variations in the

subzone can be recognized, the differences are insufficient to warrant their separation at the subzone level.

Within this subzone a few areas were observed which differ substantially from the rest of the subzone (eg. the Douglas fir stands on the east side of Chilko Lake where *Ceanothus velutinus* is present and the Douglas fir and subalpine fir stands along Tatlayoko Lake and along the west side of Chilko Lake). These areas have not been examined and are believed to be ecotone areas with unique climatic conditions.

Beil (1969) has described the plant associations from the IDF (a) and IDF (b) subzones from his area of study around Williams Lake. Additionally Beil and Hardy (1975) mapped plant associations in the IDF (b). Beil (1974) gives an excellent account of the forest (plant) associations for the IDF (b) subzone (the former "southern Cariboo zone"). Beil (1974) also discusses the Douglas fir - pinegrass plant association in relationship to similar associations in Alberta, southern British Columbia and the northern United States.

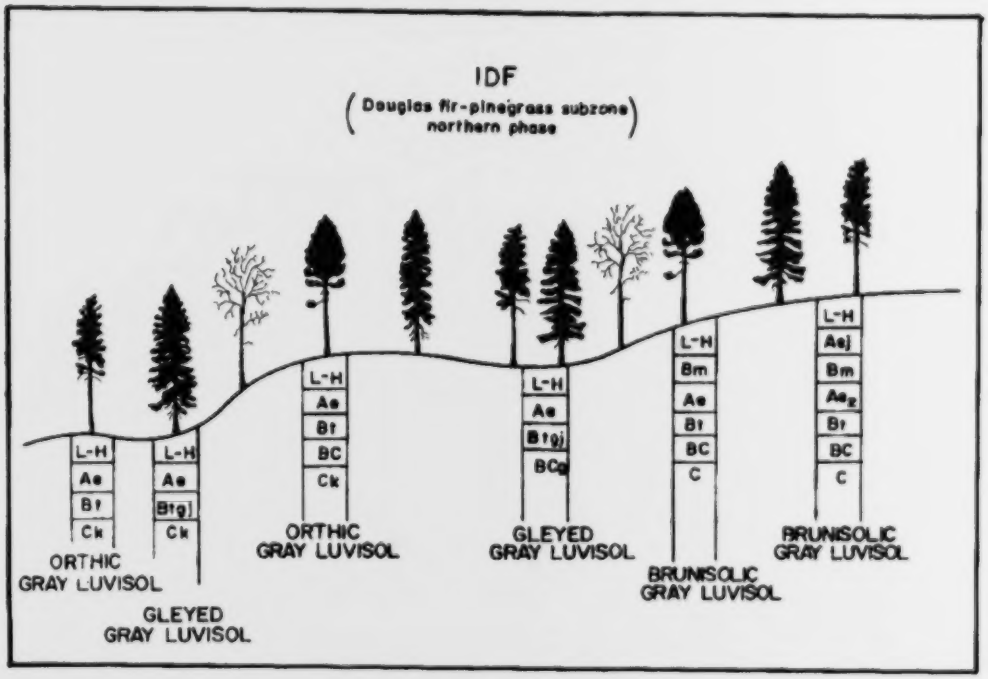


Figure 50

SOIL

The major soils of this subzone have developed on deep deposits of medium textured morainal materials (glacial till) and have an Orthic Gray Luvisolic development. These soils are characterized by a shallow organic litter layer over a silty textured light gray Ae horizon with poor structure and low organic matter content. The underlying Bt horizon is a brownish colored, dense clay enriched horizon with a distinct blocky structure. This horizon is less permeable than the Ae horizon and tends to slow the downward movement of water; a desirable attribute in an area where soil moisture deficits occur during much of the growing season. Rooting is somewhat restricted in the Bt horizon due to its high density and the tendency of the clay to shrink and swell in response to drying and wetting. The depth of the Bt horizon varies according to texture and precipitation with deeper Bt horizons found in coarser textured (sandy loam) parent materials and under conditions of higher moisture regimes (north aspects, higher elevations, higher precipitation). As the climatic moisture regime increases towards the east, soils tend to develop a brownish Bm horizon beneath the litter layer, indicating that soil development is tending towards Brunisolic Gray Luvisols.

Management of Gray Luvisols requires enhancement of the organic matter content of the Ae horizon which otherwise tends to puddle when wet and subsequently forms surface crusts on drying and which have a low nutrient status. The soil is relatively resilient when dry but compaction can occur when operating machinery under wet or moist conditions. Soil recovery from compaction is slow.

RANGE

The Douglas fir - pinegrass subzone is one of the most important forested subzones for the purpose of cattle forage production since it is relatively productive. As a result of the tremendous size of this subzone, it contributes the majority of the summer grazing to the ranchers in the Cariboo.

Initial production figures show approximately 1000 kg/ha of available forage on the more productive sites. Pinegrass is usually the most predominant grass species along with wheatgrass and sedge species. Forbs such as peavine (*Lathyrus ochroleucus*) and vetch (*Vicia* spp.) also help to make this area one of the most productive and important forest subzones.

WILDLIFE

Moose, mule deer, California bighorn sheep, black bear, grizzly bear, wolves and cougars occur in the Douglas fir - pinegrass subzone. This is one of the best subzones in terms of variety of wildlife species, with relatively high browse production for ungulates in most locations.

Most of the region's mule deer winter ranges and many of the best moose winter ranges occur in this subzone. The moose winter ranges typically occur near wetlands and along the main valleys while the mule deer winter ranges occur within mature Douglas fir forest and on other dry sites where snow depth is low. During moderate winters ungulates can utilize a large portion of the subzone. However, during winters with heavy snowfalls, the mature Douglas fir forests become critical for mule deer survival and the mature timber (often pine and spruce) adjacent to wetlands become the key to moose survival. Snow depths can often be twice as deep in the open as under mature timber. The subzone is also good summer and fall range for deer and moose.

Waterfowl are common throughout the Douglas fir - pinegrass subzone. Geese are particularly plentiful along the Fraser River and smaller rivers such as the San Jose. Because open water is present early in spring, the IDF (b) subzone is used as a resting area for waterfowl moving north. Aquatic furbearers are prevalent along perennial water courses. Ruffed grouse is the most common upland game bird in the subzone with blue grouse also occurring along the Fraser River.

Logging layout design, location of access roads and the amount of cut at one time should be a major consideration for wildlife. Land alienation occurring on wildlife habitats and disturbances or alterations to wetlands in the Douglas fir - pinegrass subzone are major land management concerns.

SILVICULTURAL CHARACTERISTICS

The major commercial trees of this subzone are Douglas fir, lodgepole pine and white spruce. Both Douglas fir and white spruce are shade tolerant in this subzone with white spruce being the most tolerant on moister sites. The Douglas fir stands of the IDF (b) subzone tend to be multiaged and hence lend themselves well to shelterwood silviculture systems. Sudden exposure of advance regeneration of Douglas fir to large amounts of direct sunlight results in growth reduction of the trees. This factor favors use of selective cutting systems. Seed trees may be left throughout an area to provide shade and seed to ensure the maximum chance for natural regeneration. Planting has met very little success in the IDF (b) subzone. Slashburning, although generally not practiced has very little deleterious effect on the nutrient status of a site due to the low precipitation and therefore low leaching potential.

IDF (c) SUBZONE

The Ponderosa pine - Douglas fir subzone (IDF (c)) is centered in relatively narrow strips along the Bonaparte and lower Fraser Rivers in the Cariboo Forest Region. Annual precipitation is low however effective precipitation is higher than in the adjacent PPBG zone. The IDF (c) subzone is essentially the same as the dry subzone of the IDF described by Krajina (1969). At elevations above 1200 m in the Cariboo Forest Region the Ponderosa pine - Douglas fir subzone shows signs of being replaced by the Douglas fir - pinegrass subzone, however, these areas were too small to map at the scale used in this study.

VEGETATION

The climate of the IDF (c) favours the establishment of Douglas fir and Ponderosa pine over other tree species. Douglas fir exists as the climatic climax tree while Ponderosa pine is a successional species. The more favorable sites are often inhabited by lodgepole pine and aspen. The shrub layer in the Ponderosa pine - Douglas fir subzone, is for the most part, poorly developed. The herb layer, on the other hand, is generally well developed in this subzone and is dominated by grasses. Pinegrass and bluebunch wheatgrass are two characteristic species.

SOIL

Soils of the Ponderosa pine - Douglas fir subzone are characteristically in the Luvisolic order with a significant inclusion of Brunisolic and Chernozemic soils on rough topography. Orthic Gray Luvisols occur on moderately coarse textured morainal deposits on smooth rolling plateau areas. On moderately coarse to coarse textured materials, Orthic and Degraded Eutric Brunisols occur.

The Luvisolic soil development is weakly expressed, however the clay enriched subsoil significantly influences soil behaviour. Luvisolic development is reflected in a greater leaching of soluble salts than is associated with the development of Eutric Brunisols or Chernozems. The Eutric Brunisols adjacent to the Marble Range are developed on high lime parent materials which result in above neutral pH values.

RANGE

Forest capability is low in the Ponderosa pine - Douglas fir subzone. It is intermediate between the drier and hotter PPBG zone and the wetter and cooler Douglas fir - pinegrass subzone with plant species from both areas being found here. The presence of bluebunch wheatgrass on south slopes makes this subzone a valuable forested subzone for grazing purposes. The IDF (c) subzone contains some of the earliest forest range in the region. Ranchers are able to use the range by mid April but the lack of moisture usually experienced in this subzone makes for a short grazing period.

WILDLIFE

The major big game species of the Ponderosa pine - Douglas fir subzone is mule deer which occurs in moderate numbers throughout the year. Other species occurring in limited numbers in this subzone are black bear, cougar and moose. Blue grouse and ruffed grouse are also present.

SILVICULTURAL CHARACTERISTICS

The major species of the Ponderosa pine - Douglas fir subzone are Douglas fir, lodgepole pine and Ponderosa pine, however productivity is very low. The stands tend to be very open due to the low precipitation of the IDF (c). Much of this subzone is almost impossible to reforest by present techniques.

PONDEROSA PINE – BUNCHGRASS – PPBG

In the Cariboo Forest Region the Ponderosa pine - bunchgrass zone is confined to a narrow strip along the Bonaparte River south of Clinton. This zone as it occurs in the district has cool winters, hot summers and very low annual precipitation.

VEGETATION

Ponderosa pine is the most abundant tree occurring in the zone and is assumed to be the climax species on mesic sites, however, considerable controversy exists regarding this statement. Douglas fir and black cottonwood occur on moister sites in this zone. Lodgepole pine is believed to be absent due to the lack of acid sedimentary soils (Krajina, 1969).

On degraded sites *Artemisia tridentata* often becomes very abundant. The shrub layer is otherwise poorly developed in the PPBG zone. The herb layer is well represented by various grasses with bluebunch wheatgrass being a diagnostic climax species for the zone. The plant associations of the PPBG zone have been studied and described in detail by Brayshaw (1965 and 1970) and McLean (1968).

SOIL

Soil development in this arid zone proceeds slowly relative to other areas of the Cariboo. Dark Brown Chernozems and Eutric Brunisols are the major soils represented on the moderately coarse textured and often shallow parent materials.

RANGE

The PPBG zone is poorly represented in the region and, as a result, does not contribute significantly to the range resource of the region.

WILDLIFE

This dry zone does not support significant numbers of big game species, primarily because of the lack of vegetative cover. Some limited winter and early spring use by mule deer does occur within portions of the PPBG zone. Chukar partridge occur in some portions of the zone.

Bibliography

Beil, C. E. 1969. The plant associations of Cariboo-aspen-lodgepole pine-Douglas-fir parkland zone. Ph.D. thesis, Dept. Bot., Univ. B.C., Vancouver, B.C. 342p.

_____ 1974. Forest associations of the southern Cariboo zone, British Columbia. Syesis 7:201-233.

Beil, C.E. and S. T. Hardy. 1975. Report on the forest classification and mapping project of the Meldrum and Gaspard areas of the Cariboo Forest District. Unpublished Report, B.C.F.S. Res., Cariboo District, British Columbia. 32p.

Bell, M.A.M. 1964. Phytocoenoses in the dry subzone of the interior western hemlock zone of British Columbia. Ph.D. thesis, Dept. of Biol. and Bot., Univ. B.C., Vancouver, B.C. 246p.

Brayshaw, T.C. 1965. The dry forest of southern British Columbia. Ecol. Western N. Amer. 1:65-75.

Brayshaw, T.C. 1970. The dry forests of British Columbia. Syesis 3:17-43.

Daubenmire, R. 1968. Plant communities: a textbook of plant synecology Harper & Row, Publishers, New York. 300p.

Dokuchaev, V. V. 1898. Kucheniyu o zonakh privody. SP6.

Environment Canada, 1970. Temperature and precipitation 1941-1970, British Columbia. Atmospheric Environment, Dept. of Environment, Canada, Downsview, Ont. 94p.

Franklin, J. F. and C. T. Dyrness, 1973. Natural vegetation of Oregon and Washington, USDA For. Serv., Gen. Tech. Rep. PNW-8. 417p.

Hitchcock, C.L. and C. A. Cronquist. 1973. Flora of the Pacific Northwest. Univ. Wash. Press, Seattle,Wash. 730p.

Holland, S.S. 1964. Landforms of British Columbia: a physiographic outline B.C. Dept. of Mines and Petroleum Resources, Bull. No.48. 138p.

Illingworth, K. and J. W. C. Arlidge. 1960. Interim report on some forest site types in lodgepole pine and spruce-alpine fir stands. B.C. Dept. of Lands and Forests, For. Ser. Res. Notes No.35. 44p.

Jenny, H. 1941. Factors of soil formation. McGraw Hill London. 281p.

Kendrew, W. G. and D. Kerr. 1955. The climate of British Columbia and the Yukon Territory. Queen's Printer, Ottawa. 222p.

Klinka, K. 1976. Ecosystem units, their classification, interpretation and mapping in the University of British Columbia Research Forest. Ph.D. thesis, Faculty of Forestry, Univ. B.C. 622p.

Kojima, S. Phytogeocoenoses of the coastal western hemlock zone in Strathcona Provincial Park, British Colubmia, Canada. Ph.D. thesis, Dept. Bot. Univ. B.C., Vancouver, B.C. 322p.

Kojima, S. and V. J. Krajna. 1975. Vegetation and environment of the coastal western hemlock zone in Strathcona Provincial Park, British Columbia, Canada. Syesis, 8 (suppl. 1):1-123.

Krajina, V. J. 1959. Bioclimatic zones in British Columbia. Univ. B.C. Bot. Ser. No.1:1-47.

_____ 1960 Can we find a common platform for the different schools of forest type classification? Sylva Fenn. No.105:50-55.

Krajina, V. J. 1965a. Biogeoclimatic zones and biogeocoenoses of British Columbia. Ecol. Western N. Amer 1:1-17.

_____ 1975b. Philosophy of ecology. Ecol. Western N. Amer. 1:102-111.

_____ 1969. Ecology of forest trees in British Columbia. Ecol. Western N. Amer. 2 (1):1-147.

_____ 1971. Biogeoclimatic zonation as a basis for regional ecosystems. Paper presented to Pre-congress conference in Indonesia.

_____ 1972. Ecosystem perspectives in forestry. H. R. MacMillan forestry lecture series. Univ. B.C., Vancouver, B.C. 31p.

_____ 1973. Biogeoclimatic zones of British Columbia. A colored map of scale: 1:1,900,800 (30 mi to 1 in.) drawn by J. I. Svoboda. Published by B. C.Ecological Reserves Committee. Dept. of Lands, Forests, and Water Resources, Victoria, B.C.

_____ 1976. Biogeoclimatic zones of British Columbia. McMillan Bloedel Place, Vancouver, B.C. 12p.

Major, J. 1951. A functional factorial approach to plant ecology. Ecology, 32:392.

McLean, A. 1969. Plant communities of the Similkameen Valley, British Columbia and their relationships to soils. Ph.D. thesis. Dept. Bot., Wash. Stare Univ., Seattle, Wash. 133p.

Mueller-Dombois, D. and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley and Sons, Toronto. 547p.

Odum, E. U. 1971. Fundamentals of ecology. W. B. Saunders Co., Toronto. 574p.

Pfister, R. D., B. J. Kovalchik, S. F. Arno and R. C. Presby, 1977. Forest habitat types of Montana. USDA For. Serv. Gen. Tech.Rep. Int.-34. 174p.

Poore, M. E. D. 1955. The use of phytosociological methods in ecological investigations I The Braun-Blanquet system J. Ecol, 43:226-244.

Revel, R. D. 1972. Phytogeocoenoses of the sub-boreal spruce biogeoclimatic zone in north central British Columbia. Ph.D. thesis. Dept. of Bot., Univ. British Columbia, Vancouver, B.C. 409p.

Simonson, R. W. 1959. Outline of a generalized theory of soil genesis. Soil Sc. of Amer. Proc. 23:152-156.

Smith, C.A.S., W. Watt and K. Webb. 1975. Landtypes of McKay River watershed, Cariboo Region. Res. Brief #4, Cariboo Forest District, Mimeo. 23p.

Sukachev, V. and N. Dylis. 1964. Fundamentals of forest biogeocoenology. Oliver and Boyd, London. 672p.

Tansley, A. G. 1935. The use and abuse of vegetational concepts and terms. Ecology, 16:284-307.

Wali, M. K. and V. J. Krajina. 1973. Vegetation-environment relationships of some sub-boreal spruce zone ecosystems. Vegetatio 26:237-281.

Webb, K. 1976. Forest land classification survey and interpretation for management for a portion of the MacKay River watershed, Cariboo Forest District. M.Sc. essay. Faculty of Forestry. Univ. B.C., Vancouver, B.C. 88p.

Whittaker, R. H. 1970. Communities and ecosystems. Macmillan, London.

APPENDIX – PLANT SPECIES MENTIONED IN THIS REPORT WITH THEIR COMMON NAMES

TREES

Abies amabilis (Dougl.) Forbes	amabilis fir
Abies lasiocarpa (Hook.) Nutt.	subalpine fir
Betula papyrifera Marsh.	paper birch
Picea glauca (Moench) Voss	white spruce
P. engelmannii Parry	Engelmann spruce
P. mariana (Mill.) Britt., Sterns & Pogg.	black spruce
Pinus albicaulis Engelm.	whitebark pine
P. contorta Dougl.	lodgepole pine
P. ponderosa Dougl.	Ponderosa pine
Populus tremuloides Michx.	aspen
P. trichocarpa T. & G.	black cottonwood
Pseudotsuga menziesii (Mirbel) Franco.	Douglas fir
Taxus brevifolia Nutt.	western yew
Thuja plicata Donn.	western red cedar
Tsuga heterophylla (Raf.) Sarg.	western hemlock
T. mertensiana (Bong.) Carr.	mountain hemlock

SHRUBS

Acer glabrum Torr.	Douglas or Rocky Mountain maple
Alnus crispa (Alton) Pursh	Sitka spruce
Artemisia tridentata Nutt.	big sagebrush
Betula glandulosa Michx.	bog birch
Ceanothus velutinus Dougl.	greasewood
Cornus stolonifera Michx.	red-osier dogwood
Chrysothamnus nauseosus (Pall.) Britt.	rabbit-brush
Juniperus communis L.	common juniper
J. scopulorum Sarg.	Rocky Mountain juniper
Menziesia ferruginea Smith	false azalea
Oplopanax horridus (Smith) Miq.	Devil's club
Pachistima myrsinites (Pursh) Raf.	falsebox
Rhododendron albiflorum Hook.	white rhododendron
Ribes lacustre (Pers.) Poir.	swamp gooseberry or prickly currant
Rosa acicularis Lindl.	prickly rose
Rubus parviflorus Nutt.	thimbleberry

SHRUBS - continued

Salix spp.	willows
S. bebbiana Sarg.	Bebb's willow
S. scouleriana Barratt	Scouler's willow
Shepherdia canadensis (L.) Nutt.	soapberry
Spirea betulifolia Pall.	shiny-leaf spirea
Symphoricarpos albus (L.) Blake	snowberry
Vaccinium spp.	huckleberries
V. caespitosum Michx.	dwarf huckleberry
V. membranaceum Dougl.	tall blue huckleberry
V. myrtilloides Michx.	velvet leaf or dwarf bilberry
V. ovalifolium Smith	oval-leaf huckleberry
V. scoparium Leiberg	grouseberry

HERBS*

Agropyron spp.	wheatgrasses
A. spicatum (Pursh) Scribn. & Smith	bluebunch wheatgrass
Anemone occidentalis Wats.	mountain pasqueflower
Antennaria sp.	pussy-toes
Aralia nudicaulis L.	wild sarsaparilla
Arctostaphylos uva-ursi (L.) Spreng.	kinnikinnick
Arnica cordifolia Hook.	heart-leaf anica
Aster spp.	asters
A. ciliolatus Lindl.	Lindley aster
A. conspicuus Lindl.	showy aster
Astragalus miser Dougl.	weedy milk-vetch
Calamagrostis rubescens Buckl.	pinegrass
Calochortus macrocarpus Dougl.	sagebrush mariposa lily
Caltha leptosepala DC.	elkslip marshmarigold
Calypso bulbosa (L.) Oakes	fairy-slipper
Castilleja spp.	Indian paintbrushes
Compositae spp.	composites

* includes small woody shrubs

HERBS – continued

Cornus canadensis L.	bunchberry
Cyperaceae spp.	rushes
Dryas spp.	mountain avens
Elymus spp.	ryegrass
Empetrum nigrum L.	crowberry
Festuca idahoensis Elmer	blue bunchgrass
F. ovina L.	sheep fescue
F. scabrella Torr.	rough fescue
Fragaria virginiana Duchesne	blueleaf strawberry
Goodyera oblongifolia Raf.	giant rattlesnake-plantain
Gramineae spp.	grasses
Gymnocarpium dryopteris (L.) Newm.	oak-fern
Habenaria orbiculata (Pursh) Torr.	large round-leaved rein-orchid
Lathyrus ochroleucus Hook.	peavine
Linnaea borealis L.	twinflower
Lupinus spp.	lupines
Lycopodium spp.	clubmosses
Opuntia fragilis (Nutt.) Haw.	prickly or brittle cactus
Oryzopsis asperifolia Michx.	ricegrass
Parnassia fimbriata Konig.	fringed grass-of-Parnassus
Pedicularis sp.	elephant's-head or lousewort
Phleum alpinum L.	alpine timothy
Poa spp.	bluegrasses
Pyrola secunda L.	one-sided wintergreen
Ranunculus eschscholtzii Schlecht.	subalpine buttercup
Rubus pedatus J.E. Smith	five-leaved bramble
R. pubescens Raf.	dwarf red blackberry
Saxifraga spp.	saxifrages
Smilacina stellata (L.) Desf.	starry false Solomon's seal
Solidago spathulata DC.	dune goldenrod
Stipa spp.	needlegrass
Streptopus roseus Michx.	rosy twisted-stalk
Tiarella trifoliata L.	foamflower
Valeriana sitchensis Bong.	Sitka valerian
Vicia spp.	vetch
Viola glabella Nutt.	stream violet

MOSSES

Dicranum spp.
Hylocomium splendens (Hedw.) B.S.G.
Pleurozium schreberi (Brid.) Mitt.
Ptilium crista-castrensis (Hedw.) DeNot.
Rhytidiadelphus triquetus (Hedw.) Warnst.
Rhytidiopsis robusta (Hook.) Broth

LICHENS

Cladonia spp. (Including *Cladina* spp.)
Peltigera spp.
Stereocaulon spp.